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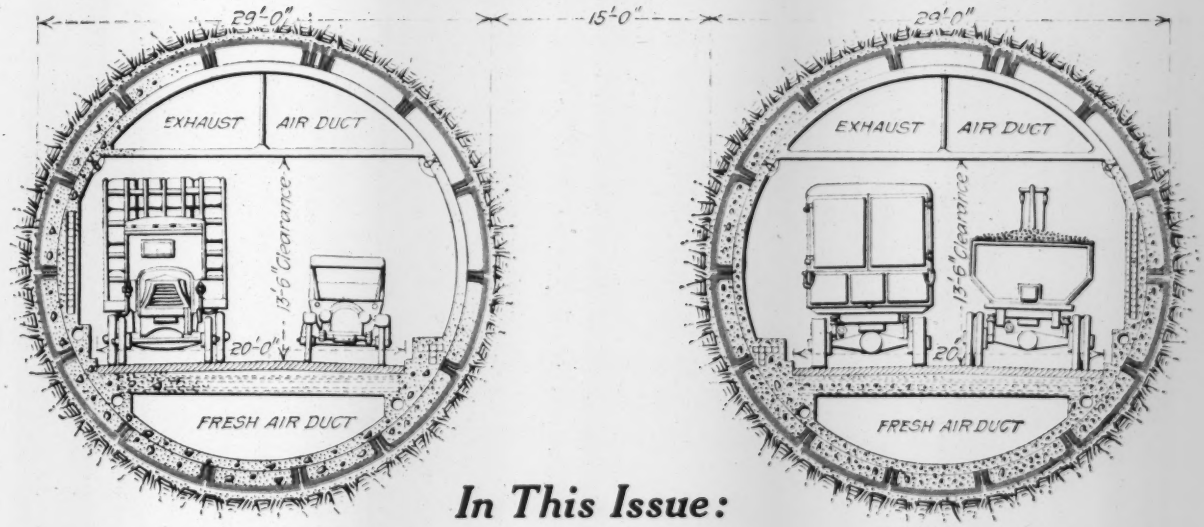

In This Issue:

Details of Proposed Vehicular Tunnel Under Hudson River

Project for connecting New York and New Jersey by Twin Tubes of Cast Iron, 29 feet in diameter, and 7345 feet long, forming

Largest Shield Tunnel in the United States

Explained in Exhaustive Report

By Chief Engineer CLIFFORD M. HOLLAND

What the Report Covers:

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New Data on Vehicular Tunnel Traffic
Ventilation Problems without Precedent
Tunnel Type Selected after Detailed Study of Eleven Plans
Total Cost Estimated at $28,669,000

Big Operating Revenue Anticipated

Figures Indicate that Cost of Structure will be Amortized in Eleven Years and that Surplus of $66,500,000 will be Produced in Twenty Years

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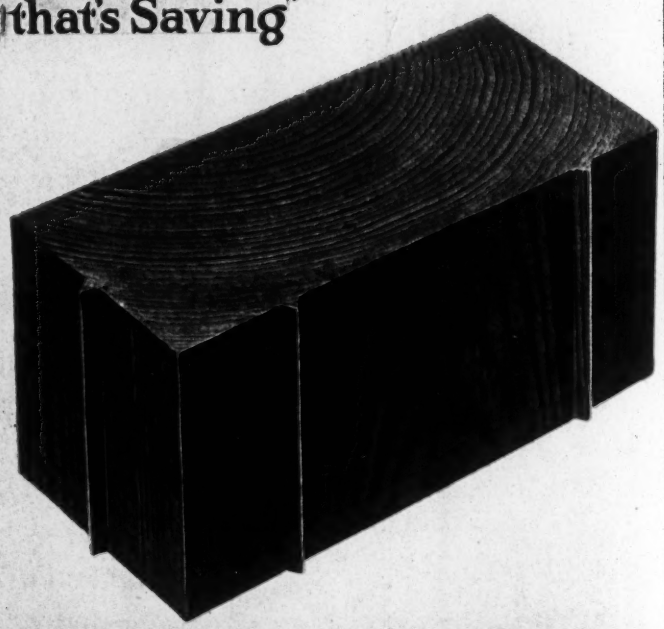

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. Mehren
Editor

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High Cost of Highways

ENGINEERS are fully convinced that, under normal conditions, expenditures for good highways are an investment that yields satisfactory returns to the public, but when costs have risen abnormally the investor must consider alternative plans for accomplishing the desired result. Last year we had to acquire the habit of considering $40,000 per mile as the proper cost for a road that could have been built for half that sum before the war. This year, if the bids recently received by the State of Pennsylvania are a fair criterion, we must decide to pay $60,000 for the identical product. Against an annual interest and amortization charge of $2,233 (interest at 4½ per cent and amortization in fifteen years) we now have an annual charge of $6,700—three times as much. No highway engineer who has any sense of values and the significance of figures can fail to set against these annual charges the cost of maintaining a cheaper type of pavement, even though he knows in advance that maintenance costs, too, have gone up. Already there is much talk of serious curtailment of highway programs until costs come down to approximately their pre-war level and when the annual charge for the better type of road will again, with a given traffic, be equal to or less than that of maintaining a cheaper surface.

Pennsylvania Road Bids

APROPOS of the preceding comment, it is interesting to note that in recently awarding 12.15 miles of concrete road in Pennsylvania the average price was $59,000 per mile, a 7.19-mile contract going for $61,000 per mile, a 2.47-mile contract for $52,500 per mile, a 1.39-mile contract for $49,000 and a 0.39-mile contract for $91,500 per mile. These are prices that make one gasp.

Labor Conditions and Drink

PROHIBITION as a factor in railway maintenance and general construction work is being noted by engineers and contractors. In railway work, especially, work train and extra gangs have been recruited largely from casual floating labor, the common procedure being that a man, after working for a short time, would draw his pay and go off for a drinking spell. After wasting his money and health, he would go back to work, usually on another job, in an unfit and inefficient condition, only to repeat the process when he had again acquired money and strength. Under present conditions it is not easy to go off "on a drunk" and the men are spending more money on their comfort and clothing. They are more critical of working and living conditions. They demand much more meat and an immensely increased amount of sweets, so that managers of camps and boarding trains have had to revise their commissary arrangements. The old camp shanties and dilapidated cars for boarding trains are no longer acceptable, and if labor is to be retained and the turnover kept within bounds, both the food and the quarters must be kept at a higher standard. Of course, the demand for better conditions has been growing during recent years, but experience indicates that prohibition is giving it a great impetus.

Peanut Politics

GOVERNOR EDWARDS, of New Jersey, is endeavoring to carry parts of his pre-election program to a successful conclusion. A bill has been introduced into the Assembly proposing a reorganization of the State Highway Department. Two of the salient provisions are the replacement of the present eight-man, unsalaried commissions by one composed of three men of the governor's own choosing, each to draw $10,000 annually; and the appointment, by the commission, of a state highway engineer "who has been a resident of New Jersey for a period of not less than five years." We have no quarrel with Governor Edwards, on theory, because of his proposal to put highway administration in the hands of three men. The question of the relative efficiency as between numerically large and small public administrative bodies has always been a debatable one. But we do protest against the destruction of an efficient commission for purely political reasons. Moreover, we take issue with him in the matter of the residence restriction placed upon the engineer. Engineering societies and roadbuilders' organizations are endeavoring to uproot from highway administration that archaic restriction. It is an enemy of efficient highway administration and a tool of the politicians. Aside from its vicious purpose, it would force out of office in New Jersey the present incumbent, W. G. Thompson, who is restoring for New Jersey her once enviable, but long lost reputation, as a good-roads state. The bill is vicious. It is a product of "peanut politics." If New Jersey wants to disgrace herself among the roadbuilders of the country, she should pass the bill.

The Exchange Situation

EVEN those who normally pay no attention to the foreign exchange situation must have felt some concern recently for the low levels that have been reached. Sterling, with a normal par of $4.86½, dropped to $3.18 early this month but returned to about $3.40 by the end of last week. Francs, quoted normally at about five to the dollar, have dropped to about 14 to the dollar. To European countries, obliged to buy the necessaries of life in this market, the situation is very serious. On the other hand, America is a good place to sell whatever they can produce and can spare. Though international bankers and the foreign governments are concerned over the situation, they, in company with our former Secre-

tary of the Treasury, Mr. Glass, draw the conclusion that the only remedy is for Europe to produce more of its own necessaries and also more exportable goods. Meanwhile, the situation is apt to prove favorable to us. As a result of the high cost to Europeans of buying in this market, our export trade is falling off. The goods are being thrown back upon the domestic market and the result should be a reduction in price here. If ours were a glutted market, this reduction in our export trade might be looked upon with alarm, but with our universal shortage there is no likelihood of serious disturbance. What price reduction there will be may probably come gradually.

Economics of Highway Location

ALL engineers interested in highway work will, we are sure, be fully in accord with Mr. Syme (see page 383) in his plea for some competent authority to give us a practical treatise on "The Theory and Practice of Highway Location." What is needed is another Wellington to do for the rising field of highway transportation what that great authority did for railway location in the seventies. Possibly it is too much to hope for a work of authority at this comparatively early date in motor-truck transportation. The experiences are not adequate enough, nor the data sufficiently complete. Railroading was nearing the status of a matured art when Wellington in the seventies wrote his great treatise on "The Economic Theory of Railway Location." We have not today even ten years' experience in the use of the motor truck for transportation over rural roads. Possibly we are too hopeful in wishing for a Wellington at this date, but eventually some one with his masterful mind must do for the highways what he did for the railways.

Engineering Education in Canada

ENGINEERS in this country will read with much interest the address by Brig.-Gen. C. H. Mitchell at his inauguration as Dean of the Faculty of Applied Science and Engineering at the University of Toronto last October, reprinted on page 369 of this issue. Not only will there be interest in the changes that he indicates in the relative importance of the branches of engineering in Canada, but also in the evidence that the thinking regarding engineering education there is following much the same lines as it is in the States. Here we long since passed the time when civil engineering was predominantly the leading specialty. More than twenty years ago the industrial courses came to the fore, responding to the demands which practice was making on the colleges. In Canada the transition is now under way. On the other topic—the broad consideration of engineering education—we recognize some of the ideas that have been stirring on this side of the international line—the need for training broadly cultured men and good citizens and the establishment of closer relations between the colloges and practical work. But while giving consideration to these pressing phases of engineering education, there is in Canada a solid standing upon the need for "thoroughly educated technologists." The progress on this broad subject at the University of Toronto, a progress backed by solid enthusiasm, will be followed with interest by our engineering educators here. The problem is so important that the progress in all quarters needs to be brought together and appraised for the benefit of the profession.

The Real Revolution

THE industrial revolution which was to have broken upon us by the rockets' red glare and bombs bursting in factories has limped its way into the limbo of catastrophies unfulfilled; but the real industrial revolution of the head and heart—not of the lungs and larynx—is quietly fulfilling the unprophesied.

It required the fear of fury to stir the imaginations of many employers sufficiently for them to reach out and grasp a few simple axiomatic truths—the obvious truths that underlie successful industrial relationships. Even some of the I-by-the-grace-of-God employers can be heard agreeing that certain things "pay." And the large body of decent employers who earnestly but misguidedly sought without their plants for some complex and mystical formulas to allay unrest, have quickly begun to translate the old and homely truths into terms of today's work. The recent conviction that "we must fight it to a finish," which was so assuasive when conscience crowded, is going also into the limbo of long-held lunacies. The industrial revolution is coming like a gentle sunrise rather than like a midnight thunder storm. So all real days dawn.

The truths that are making men free—free from shackling suspicions of each other—can be phrased in words of one syllable:

As ye sow, so shall ye reap.

Psychologists, philosophers and industrial doctors have produced volumes shot through with sonorous words to say just this. If you seek light, don't read them. Any man really seeking the light has the whole philosophy of management in these seven words:

A man's a man for a' that.

Shortcomings are the distinguishing mark of the species. The American man won't stand petty rules and paternal regulations. He wouldn't be much of a citizen if he did. He'd be a poor producer, too. A man's weak spot is his strength; all of us "fall" for decent treatment.

A man who stays with you is better than ten who leave.

Ask the manager who has reduced his turnover. Ask him, if you will, in terms of production. And then if you consider yourself a real manager, prove you are one by organizing to have men stay with you—or failing it, confess you are not a real manager. A real manager never hides behind alibis. He doesn't need to.

Hands and head and heart do ten times as much as hands.

The employer whose employees fail to put their whole effort into the job is getting a poor return from his floor space, equipment and pay roll. The whole effort can be gotten. It is being done. The manager who doesn't get it doesn't prove it can't be done; he merely proves that he can't do it. Management is the art of dealing successfully with men and their ways rather than with materials and their laws. By their fruits ye shall know managers.

But it all comes back to the first: *As ye sow, so shall ye reap.* The extent to which bolshevism grows in any land is probably in exact proportion to the preparation which the ground has had for that kind of seed. The winds that blow have little to do with it. Management which fails to take men as God made them into account is bound to reap a whirlwind, and that management is worse than bolshevistic which says, "After I get mine, let the whirlwind come!"

The proximity of the whirlwind has been a good thing. It is working a change in the souls of men. Being men they carry a bit of the old brag about still—and this proves that they are very human—to hide their conversion. But it is there. And it is the great industrial revolution—a revolution not of mighty manifestos, forced formulas, wrested agreements, and threatening tension, but the realization of the meaning of one sentence:

As ye sow, so shall ye reap.

A New Conception of the Snow Removal Problem Needed

NOT for many years has a storm tied up traffic in New York City so thoroughly as did the heavy fall of snow two weeks ago. Street car lines suspended operation for days, the elevated railways had difficulty in keeping trains moving, while the number of horse-drawn vehicles and motor trucks stalled in the deep drifts and ice "craters" brought back pictures of the traffic derelicts along the mired roads of France during the war. It takes a situation of this sort, where everything on wheels is either at a standstill or moving at a snail's pace, where one has to plod to work instead of riding in comfort to make the average man realize just what transportation means in the life of a great city. We are too apt to take our transit facilities for granted. But in spite of the jolt given to New York this month it is too much to expect that the real lesson of the storm will be learned. Neither the general public nor the present city administration has grasped the fact that snow removal is an engineering problem. Good progress toward a solution was made while an engineer, John T. Featherston, was street cleaning commissioner—but he was promptly deposed when the new city administration came into power after the defeat of Mayor Mitchel.

Snow removal is essentially *emergency* work. In New York a snowstorm may create critical traffic conditions only half a dozen times, or less, a year. The result is that the snow problem is slighted in favor of others of an all-the-year-round nature. Its solution is dependent upon preparedness for an emergency, and as such it has little or no appeal to the American public. It is difficult, when the thermometer registers 90 deg. in the shade, to get city officials to believe that a demand for money to insure adequate organization and mechanical equipment for handling snow is anything but an attempted raid on the city's strong box. Nevertheless, the one way in which the snow problem can be handled more effectively than at present is by advance planning and the wider use of machines instead of hand shoveling.

Of course, no city would provide a big outlay in plant which would be used for only a few days a year. There is, however, a field open for investigation in the adaptation of contractors' standard plant, such as mechanical loaders, and earth excavating and handling machinery—ordinarily idle during winter—to the needs of snow removal. With slight modifications in some of these machines it is reasonable to believe that a much greater yardage of snow could be handled than by present methods. The average city, however, is apt to look askance at any proposition involving the spending of money on experiments in speeding up snow removal. The attitude is one of waiting till the emergency has arrived and then making the best of it with whatever means may be at hand.

If the policy in force were one of progress and preparedness, the great labor employing agencies of the city, such as the general contractors, the express companies and the railways, might be mobilized. Mechanical equipment, in storage awaiting the opening of the construction season, could be pressed into service. With snow banked up in mounds 6 ft. high along every street in New York, steam shovels, locomotive cranes and buckets and other forms of contractors' plant could be used effectively in loading the material on wagons and motor trucks. The vital point is that the problem can be solved only if it is conceived of as a *real emergency*. It cannot be attacked effectively without bringing into play every means that can help. Nor can plans be made the day the storm arrives. The campaign must be worked out *months in advance*, so that when the crisis arrives the city will be prepared to tackle it in a big way.

The situation in New York City was due to a combination of three chief causes: (1) The snow, especially the first 6 or 7 in., was extremely dense—two and a half times the average—weighing probably 30 lb. per cubic foot as compared with a normal weight of about 12 lb. per cubic foot. It was of low temperature, hard and granular, instead of flaky, and readily packed down into a frozen mass or drifted into the underground-trolley slots, piling up in the duct space to such depths that the feeder rails were effectively put out of service. (2) Shortage of labor was, perhaps, the biggest factor in the situation. The Street Cleaning Department's regular forces are entirely inadequate in numbers for a real emergency. Dependence must be placed on outside help. The pay of 50c. an hour apparently was not sufficient to induce more than a small percentage of the men actually needed to report for work. (3) The Street Cleaning Department itself needs to adopt more progressive tactics. If the right sort of engineering personnel were available in the department the city might well provide funds for a thorough study of mechanical plant as a means of accelerating the removal of snow.

Certain it is that the department has failed utterly to measure up to the needs of the present situation. While due allowance must be made for the labor shortage and the unusual character of the storm, it is clear that the methods—or lack of methods—in use by the largest city of the United States today are woefully inadequate.

Big storms should be handled by the same system of priorities which the General Staff of our Army employed in France in distributing transportation and troops where they were most needed. For example, if an attack was contemplated in a certain sector everything else had to give way to the rushing of supplies and men to that locality. This action robbed other sectors of both personnel and motor trucks, but that was necessary at critical times.

If the city officials and the people of New York City could be induced to accept the principle of priorities when a big snowstorm occurs there would be little danger of the complete traffic paralysis which has just been witnessed. The acceptance of this principle would mean that every vehicle, every steam shovel or other machine applicable to the work, and every man that could be of service in removing snow would be detailed thereto. While this would mean a certain loss to the companies and the individuals entering upon the work, it is very probable that a substantial saving could be made in the end by keeping the streets clear. The pres-

ent tie-up, the Merchants' Association estimates, has caused a loss of $5,000,000 per day—and the tie-up, twelve days after the storm, still continues.

Army methods and the intelligent use of mechanical plant would do the work. To put them successfully into effect would require a vast amount of *advance* planning on the part of the Street Cleaning Department. A strategical campaign and schedule of mobilization would have to be worked out in co-operation with the various public and private interests concerned. The first step, however, is the creation of an entirely new conception of the snow problem by city officials and by the public. Its planning and execution is a job for engineers.

A Highway Under the Hudson

WITH the decision of the chief engineer of the New York and New Jersey tunnel commissions in favor of the shield method of driving and cast-iron lining for the vehicular tubes under the Hudson River, as discussed in detail in the report on p. 357, clearness is brought into a matter that has been involved in much interesting speculation and divergence of expert opinion. Several prior projects for the tunnel involved untried elements, which, however interesting, would probably have weighed heavily against the chances of financing the enterprise readily. The present recommendation, made in anticipation of immediate construction, for whose conduct the engineering staff of the interstate commissions will be responsible, follows lines of practice thoroughly tried out by experience, and thereby carries with it a guarantee of success and freedom from unexpected checks.

Four or five years ago a board of engineers, studying the problem of building a large-capacity street tunnel under the Hudson for private interests, recommended the "trench" method of construction, in which sections of tunnel built on land were to be floated out into the river and sunk to place on a prepared foundation. According to their calculations, this method was the cheapest. Other engineers, however, believed that the estimate had not allowed adequately for the uncertainties involved, partly on the score of unsatisfactory subsoil for founding and anchoring the structure and partly on the score of interference with shipping. Indeed, later General Goethals, in studying the problem for the states of New Jersey and New York, condemned the method on the score of difficulties arising from the semi-liquid accumulations on the river bottom. His own recommendation, however, was no less novel, and, in the opinion of many experienced tunnel men, hazardous; he proposed a shield-driven tunnel of 42-ft. diameter, which is so far beyond precedent that there were grave doubts concerning its feasibility. Moreover, he abandoned the known and dependable iron lining in favor of concrete-block lining, of unknown characteristics as regards transverse and longitudinal resistance to the forces of attack in soft-ground subaqueous work. The present engineers' report states that an analysis of forces and resistances indicates the proposed concrete-block structure to be dangerously weak. Its capacity, too, is shown to be overestimated. After these radical projects the final recommendation is reassuring in its conservatism, even though the work of driving two 29-ft. tubes through the silt and rock bed of the Hudson is anything but easy routine work. If there were no other advantage in the decision reached, it would merit commendation because it makes the Hudson highway tunnel a definitely predictable reality, which will be giving service—a service very badly needed—in the shortest possible time.

Outranking all the discussion and analysis of tunnel types, the traffic studies on which the design is predicated have great engineering importance. They demonstrate with almost startling clearness the urgent necessity of providing better means for crossing the Hudson than the present ferries. When it is shown that the proposed tunnel will not only pay its keep, but will return its entire cost within a dozen years, there is no need for further evidence of the vital business importance of an efficient crossing, whether tunnel or bridge. The transportation or interchange facilities of the metropolitan group of communities are crippled by want of an indispensable link. For years past advocates of Hudson crossing projects talked to deaf ears; now their arguments find complete confirmation.

Not only will there be a large gain of time and of certainty of schedule to the present trans-Hudson traffic, but new traffic will be built up, which means increased efficiency of production and distribution. Ferry facilities for team traffic have long been overtaxed, and yet the traffic is growing at a remarkable rate. There is no room for expansion of ferry service, in competition with the claims of other waterfront activities. In short, the business of the densely crowded populations on opposite banks of the Hudson has simply outgrown the capacity of old-time machinery of inter-communication.

Not only does the dividend-earning power of the vehicular tunnel prove this, but also the fact that within ten or fifteen years there will be enough traffic to call for the construction of a second line of communication. The estimates of the tunnel commission's engineers—and they are unusually devoid of contingent speculations—set this forth in figures. But it should be apparent even without quantitative estimate that a business community of six million people, cut off from its outliers and from the whole country beyond by a broad shipping channel, has traffic needs that cannot be satisfied by a single four-way road across this channel. The situation is one in which traffic depends on facilities, not facilities on traffic.

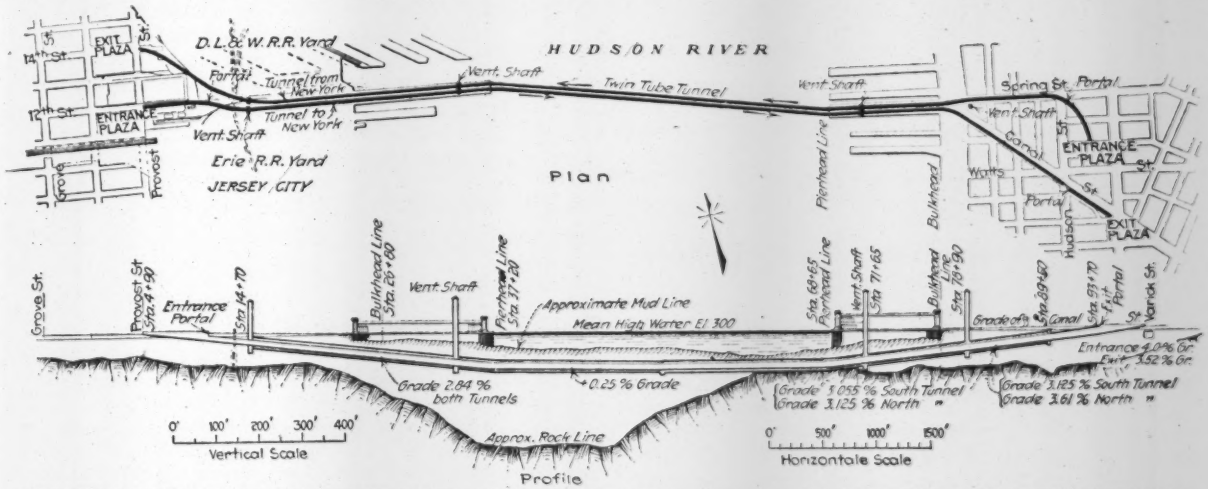
The total cost of the tunnel project, including construction, equipment and real estate, is estimated by the chief engineer at $28,669,000, of which amount $22,262,000 represents actual construction, figured at present prices for labor and materials, with an allowance for contractors, contingencies and profit. Lower cost estimates have been made for other types of crossing, but these are in most cases based on pre-war prices. Obviously they are useless as a measure of comparison with the present estimate and, in certain cases, are believed greatly to understate the expense of doing work by untried methods for which—unlike the case of the cast-iron tubes—there is no precedent to guide in the estimation of costs.

But the cost figures should not be considered alone, but in relation to the revenue which the tubes will produce. The figures show that the cost will be amortized in 11 years after the project is completed and that in 20 years a surplus of more than $66,000,000 will be divided between the States of New York and New Jersey. On this basis the soundness of the project is so obvious that steps should be taken to put the work under construction at the earliest possible date.

Largest American Shield Tunnel Designed to Carry Vehicular Traffic Under Hudson River

Twin Tubes of Cast Iron, 29 Ft. in Diameter, Recommended by Chief Engineer C. M. Holland for New York-New Jersey Connection—Project to Cost $28,669,000—Operating Revenues Expected to Amortize Cost in 11 Years and Produce Surplus of $66,500,000 in 20 Years—Many Special Problems, Such as Traffic and Ventilation, Studied

TWIN tubes of cast iron 29 ft. in external diameter, larger than any existing American subaqueous tunnel of the shield-driven type, and representing the first shield tunnel in the United States designed for the exclusive use of motor and horse-drawn vehicles, have been recommended for the interstate vehicular connection, under the Hudson River between New York and New Jersey. The mean length of the cast-iron ring section is 7,345 ft., while the distance between grade points of the tunnel—which includes the open-cut approaches—is 9,300 ft. The decision as to the type also is one of the important problems dealt with in the report, the special feature being the removal of the noxious exhaust gases from motor vehicles (particularly carbon monoxide), which will be the biggest users of the tunnel. Of great significance is that part of the document which deals with the project's finances. It is predicted that in 11 years after the tubes are completed they will have yielded in operating revenue a sum sufficient to amortize the construction cost, and that in 20 years a surplus of $66,500,000 will have been produced. It is estimated that the tunnel



LOCATION PLAN, INDICATING ENTRANCE AND EXIT ARRANGEMENT, AND LONGITUDINAL SECTION SHOWING LINE OF RIVER BED AND ROCK

of tunnel and data covering the engineering and financial features of the project, the total cost of which is estimated at $28,669,000, are contained in a report by Clifford M. Holland, chief engineer of the New York State Bridge and Tunnel Commission and the New Jersey Interstate Bridge and Tunnel Commission, made public this week.

The design of the 29-ft., cast-iron shield type of structure, following closely well-established subaqueous tunnel practice, provides in each tube a 20-ft. roadway for two lines of traffic (both lines being in one direction in each tube) and was chosen in preference to a variety of other types proposed, including a double-deck concrete-block tunnel 42 ft. in diameter, a precast reinforced-concrete tunnel, a concrete tunnel with steel shell and an outer protection of concrete placed by the tremie method, and cast-iron tubes of diameters larger or smaller than the one adopted. Mr. Holland devotes considerable space in his report to a discussion of vehicular traffic with relation to tunnel design and carrying capacity and presents much new and valuable material based on observed traffic conditions at New York City's bridges and ferries. Much study has been given to the subject of entrance and exit design. Ventilation in the proposed tubes construction will require 3½ years to complete. The cost, as well as the revenue, will be shared equally by the States of New York and New Jersey. With decisions made on the important engineering features of the project the way is clear for placing the work under contract this summer if the State Legislatures take action on providing the funds for construction. The more important parts of Mr. Holland's report, which has been approved by a board of consulting engineers consisting of Col. W. J. Wilgus, J. A. Bensel, Wm. H. Burr, Edward A. Byrne and J. V. Davies, are given below in the form of abstract and direct quotation:

Location—The location of the tunnel, as shown in the accompanying drawing, was selected because, on the New York end, Canal St., a wide east and west thoroughfare, is approximately at the center of the downtown traffic over the Hudson River ferries and gives direct communication across Manhattan Island, connecting with the East River bridges and Brooklyn and with the Hudson River waterfront. The location has the advantage, also, of low surface elevation on both sides of the river, resulting in the shortest possible approaches. The Jersey end of the tubes is fixed at a point almost directly opposite Canal St., thus giving a

tunnel of minimum length. The Jersey terminus is near the center of traffic and affords direct communication with Jersey City Heights and points beyond by means of the 13th St. viaduct, while the waterfront and railroad yards are easily accessible.

The north tube is to be used only for westbound traffic (from New York to New Jersey), while the south tube will be devoted entirely to vehicles moving in an easterly direction.

Entrances and Exits—The volume of traffic on the city streets in the vicinity of the tunnel portals is constantly increasing and will be greatly augmented at the time the tunnel is completed. In New York the entrance and exit are separated by locating one to the north and the other to the south of the through Canal St. traffic. They are so located as to be served by two main north and south avenues so that the tunnel traffic is afforded the best facilities obtainable for free movement, and at the same time the greatest possible separation is secured at a reasonable cost. In Jersey City the same principle has been adopted

Traffic conditions in the tunnel differ from those on city streets in that the only points where the continuity of traffic can be interrupted by cross traffic is at the entrances and exits. Consequently, these points are of vital importance as affecting the ultimate capacity of the tunnel. The separation of the tunnel entrance and exit traffic, the report points out, is a factor of the greatest importance in relieving congestion in the vicinity of the tunnel.

Provision is made for adequate plazas at the entrances which will serve to accommodate the waves of traffic as they approach the tunnel, thereby insuring continuity of movement through the tube. Furthermore, sufficient space must be provided for the increased number of lines of traffic which, during the collection of tolls, will move slowly. These additional lines will converge in the portal roadway into continuous lines of vehicles through the tunnel. At the exits the provision of adequate plaza space for free and continuous movement of traffic away from the tunnel is of equal importance.

Depth and Grades—One of the drawings shows a plan and longitudinal section of the tunnel under the river. War Department restrictions require the top of the tunnel, between pierhead lines, to be at least 50 ft. below mean low water. The tube, of course, will require a sufficient cover to protect it from damage by dredging, anchors of ships, or sunken vessels, and to resist upward movement of the tunnel.

Surveys and Borings

The tunnel location is based upon records of borings made by the Public Service Commission of New Jersey in 1917, and upon additional boring data secured by the present interstate bridge and tunnel commissions at a cost of about $21,000. The approximate profile of the bed of the Hudson River and the rock line are shown on one of the drawings.

The character of the upper layer of material in the bed of the river was found to be a black deposit, the top of which is in a semi-fluid condition, and by chemical analysis is shown to be of organic origin, probably the sediment from sewage. This material is deepest near the shores, varying in depth from 5 to 20 ft. in the slips, but in the channel little or none is found. Underneath the upper layer of black mud is Hudson River silt, composed principally of clay, but containing a considerable percentage of very fine sand or quartz. The great mass of this formation lies in the center of the river filling up the old Hudson River gorge. Directly overlying the rock there is a layer of hardpan containing boulders, or in some cases a layer of coarse sand, both of which are probably of glacial origin. This layer of material, in places, is 15 ft. thick. On the New York shore the underlying rock is the typical Manhattan schist, while at the New Jersey shore serpentine is found, and farther west triassic sandstone.

The behavior of the Hudson River silt during dredging operations to any considerable depth, the report states, is problematical, but undoubtedly the upper layer of mud, which is almost a fluid, would wash into any trench dredged across the tidal currents.

During the borings samples of the ground-water and of the upper layer of black river mud were taken and analyzed to ascertain whether they contained anything injurious to the tunnel structure. No acid ground-water sufficiently concentrated to endanger the permanency of the completed structure was found. While the analysis of the river material, particularly that near the surface in the vicinity of the bulkheads, indicates a considerable quantity of sulphur compounds, the material at lower elevations is practically free from them. It would not be a difficult matter, if it should be considered advisable, to remove the surface deposit above the tunnel structure and replace it with non-injurious material.

Traffic

As a basis for estimating the amount of traffic which would use the vehicular tunnel the information in the accompanying diagrams, based on counts at ferries and bridges, was collected and is discussed at some length as follows:

In summarizing and classifying the data, the ferries are divided into groups. The first group consists of the five ferries nearest the tunnel, from which the greater part of the tunnel traffic will be diverted. At the present time this group carries 11,100 of the 22,600 vehicles daily transported across the Hudson River or 49 per cent of the total. This group is referred to as the "Five Ferries," namely:

Pennsylvania R.R.	Desbrosses St.
Pennsylvania R.R.	Cortlandt St.
Erie R.R.	Chambers St.
D., L. & W. R.R.	Barclay St.
D., L. & W. R.R.	Christopher St.

The second group consists of six ferries farther from the tunnel and it is probable that their traffic will be less influenced by its opening. At present this group transports 6,200 vehicles daily or 27 per cent of the total ferry traffic. This group is referred to as the "Six Ferries," namely:

Central R.R. of N. J.	Liberty St.
Central R.R. of N. J.	W. 23rd St.
Erie R.R.	W. 23rd St.
D., L. & W. R.R.	W. 23rd St.
14th St. Hoboken	W. 23rd St.
West Shore R.R.	Cortlandt St.

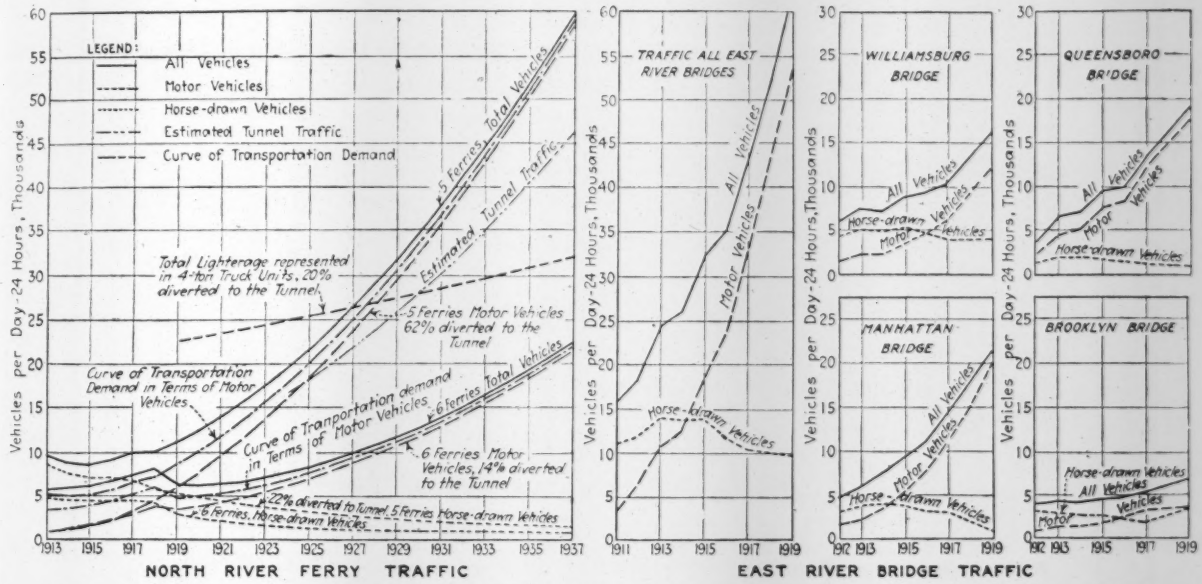
The third group of ferries includes those at West 42nd St., New York, and all ferries north of this point. They are so far away from the tunnel, that while some traffic may be diverted from them, none has been included in estimating the tunnel traffic. Some traffic now reaching New Jersey by way of Staten Island may be diverted to the tunnel, but its volume is considered negligible.

Between the years 1913 and 1919 the daily traffic over the "Five Ferries" increased from 9,600 to 11,100 vehicles, an increase of 1,500 vehicles per day in 6 years. In analyzing this increase it is found that the motor-vehicle transportation has increased from 900 vehicles per day in 1913 to 5,900 vehicles per day in 1919, while the horse-

drawn vehicles have decreased from 8,700 per day to 5,200 per day. Considering that the average motor truck has a capacity of at least two horse-drawn vehicles it is evident that in the decrease of the horse-drawn vehicles and their replacement by motor trucks, the growth in traffic tonnage has been greater than is indicated by the actual increase in the number of vehicles. In order to determine the real traffic increase during the past 6 years and to forecast properly the future increase, all of the traffic has been reduced to the basis of motor vehicles. In this reduction two horse-drawn vehicles are considered to have the same capacity as one motor-driven vehicle and a curve of transportation demand (see diagram) has been plotted, which shows a gain in 6 years from 5,200 to 8,500 vehicles, a 63 per cent increase as against 16 per cent when computed from the actual number of vehicles crossing the river. It is found that improved methods of communication. As shown on the curve of traffic over the "Five Ferries," it is estimated that the increase will be about 340 per cent in the next 15 years, while in the case of the "Six Ferries" it will be about 200 per cent; the combined increase of the two groups is about 280 per cent.

If the estimated increase in traffic across the Hudson River, as based on the growth of ferry traffic during the past 6 years, is compared with the growth of traffic over the East River bridges, as shown in the curves, it is apparent that the estimated increase is far less than that in the traffic over the bridges where, during the past 7 years, the growth for all the bridges has been about 250 per cent or nearly twice that estimated for the ferries.

In forecasting the tunnel traffic, according to the report, consideration must be given to the probable


LEGEND:
All Vehicles
Motor Vehicles
Horse-drawn Vehicles
Estimated Tunnel Traffic
Curve of Transportation Demand
Vehicles per Day-24 Hours, Thousands
5 Ferries, Total Vehicles
Estimated Tunnel Traffic
Total Lighterage represented in 4-ton Truck Units, 20% diverted to the Tunnel
5 Ferries Motor Vehicles 62% diverted to the Tunnel
Curve of Transportation Demand in Terms of Motor Vehicles
Curve of Transportation demand in Terms of Motor Vehicles
6 Ferries, Total Vehicles
6 Ferries, Motor Vehicles, 14% diverted to the Tunnel
22% diverted to Tunnel, 5 Ferries Horse-drawn Vehicles
6 Ferries, Horse-drawn Vehicles
1913 1915 1917 1919 1921 1923 1925 1927 1929 1931 1933 1935 1937
NORTH RIVER FERRY TRAFFIC
TRAFFIC ALL EAST RIVER BRIDGES
All Vehicles
Motor Vehicles
Horse-drawn Vehicles
1911 1913 1915 1917 1919
WILLIAMSBURG BRIDGE
QUEENSBORO BRIDGE
MANHATTAN BRIDGE
BROOKLYN BRIDGE
1912 1913 1915 1917 1919
EAST RIVER BRIDGE TRAFFIC

TRAFFIC CURVES SHOWING DATA ON EXISTING BRIDGE AND FERRIES AND PROBABLE TUNNEL TRAFFIC

the increase from year to year is not constant but is slightly greater each succeeding year. This curve and a similar curve of transportation demand for the "Six Ferries" are used in estimating future traffic across the Hudson River south of 42nd St., New York. The rapid rise in the "Six Ferries" from 1916 to 1918, inclusive, was probably due to war-time activities at the Hoboken docks directly served by the D., L. & W. ferries. The count in 1919 was made in August and September after this activity had practically ceased.

If the motor-truck traffic curves are carried forward at the present rate of increase, they will practically parallel the curve of transportation demand within a few years, while if the number of horse-drawn vehicles continues to decrease at the present rate, within ten years their number will be comparatively small, although a considerable volume of horse-drawn traffic will still continue to seek passage across the river. The forecast of traffic increase for the "Five" and "Six Ferries" is of considerable magnitude, but it does not nearly equal the rate of traffic increase over the East River bridges in the past, which is as follows:

BRIDGE TRAFFIC, 1912-1919

	Daily Traffic 1912	Daily Traffic 1919	Per Cent Increase in 7 Years
Brooklyn Bridge	4,000	6,700	67
Manhattan Bridge	4,800	21,400	345
Williamsburg Bridge	6,000	16,300	172
Queensboro Bridge	3,500	18,700	435

The rapid increase in traffic over the East River bridges, where an uninterrupted means of transportation is furnished, shows the tendency of traffic to increase with large increase in the use of motor trucks and to the use of the vehicle tunnel for transporting freight now carried across the Hudson River by lighters. The D., L. & W., Pennsylvania, and Erie railroads, at the present time, lighter daily across the Hudson in both directions approximately 60,000 tons of freight. The report continues:

In the absence of reliable data one-fifth of this lightered freight traffic, with an allowance for its growth up to 1924, is assumed to be trucked through the tunnel, requiring 3,240 four-ton trucks for its movement. As it is necessary for the trucks to make a round trip, there would be a total daily traffic through the tunnel of 6,480 trucks, but it may be assumed that one-half of the trucks will be loaded in both directions, which would supply to the tunnel from this source 4,860 vehicles daily.

The percentages of each class of vehicles which will cross the river by the tunnel are assumed as follows:

TRAFFIC FROM A DISTANCE—NEWARK-PATERSON

	Five Ferries, Per Cent	Six Ferries, Per Cent	Four Ferries
Pleasure cars	90	25	0
Motor trucks	75	10	0
Horse-drawn vehicles	40	0	0
NEARBY TRAFFIC—JERSEY CITY:			
Pleasure cars	75	20	0
Motor trucks	50	10	0
Horse-drawn vehicles	20	0	0

The percentage in each case is based upon the total number of vehicles of its class in each ferry group. The above

varying percentages, each applied to its special class of traffic in the respective ferry groups, produce an average of 62 per cent for motor vehicles, and an average of 22 per cent for horse-drawn vehicles over the "Five Ferries," and an increase of 14 per cent for motor vehicles over the "Six Ferries."

Upon the above basis the estimate shown in the curves has been made.

The estimated yearly tunnel traffic (assumed to be equivalent to 340 times the average week-day traffic) in 1924 is approximately 5,610,000 vehicles, or about equal to the traffic over the Williamsburg bridge at the present time. In 1934 it is estimated that the traffic demand will reach 12,900,000 vehicles annually.

Traffic Capacity of Tunnel

In determining the traffic capacity for which the tunnel should be planned the report states that the chief considerations are: (1) Volume and character of the vehicular traffic which will seek the tunnel. (2) Capacity of one, two and three lines of traffic in each direction. (3) Economical size of tunnel in relation to amount of traffic. (4) Limitation of capacity by street congestion in vicinity of tunnel entrances and exits.

It is estimated that the number of vehicles which would use the tunnel, is as follows:

1924	5,610,000	1937	15,700,000
1935	13,800,000	1943	22,300,000

Roadway Capacity—The capacity of one, two and three lines of traffic depends on the operating speed and spacing of vehicles in the various lines. The following capacities have been given in connection with previously proposed tunnels for the Hudson River crossings:

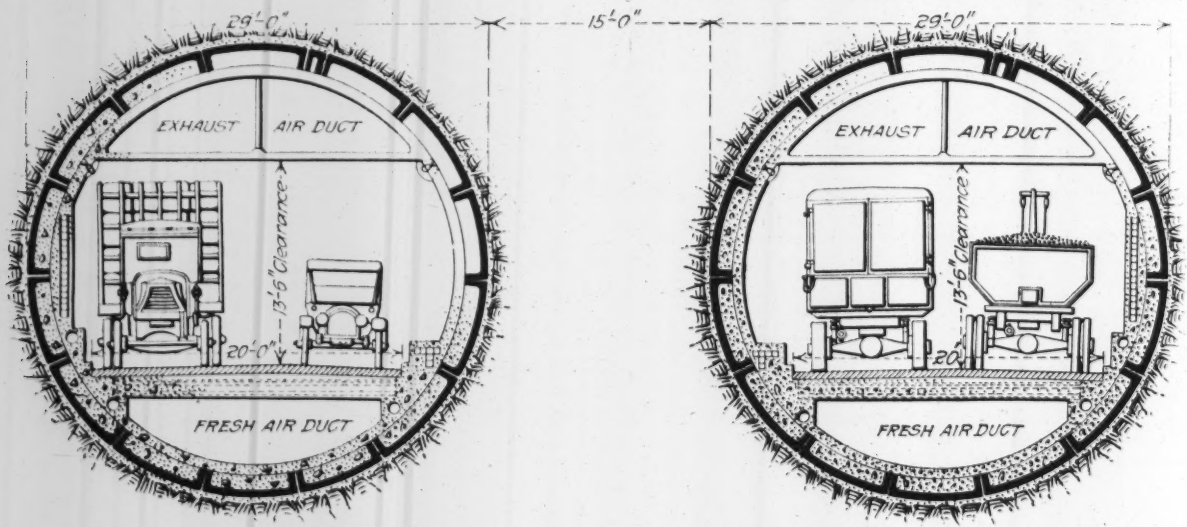
	Vehicles per Year
Jacobs & Davies—Two lines of vehicles in each direction	5,000,000
Burr, Modjeski & Moran—One line of vehicles in each direction	7,700,000
Goethals—Three lines of vehicles in each direction	36,500,000

It is apparent, according to the report, that these figures have not been made on a uniform basis and are, therefore, not a true comparison of the relative capacities of tunnels with one, two and three lines of traffic in each direction.

For a more rational comparison, a uniform basis for estimating the capacity was established from a study of the traffic conditions on the East River bridges. The grades in the tunnel will be practically the same as those on the bridges, so that these conditions are directly applicable to the tunnel. In applying the results of the speed and spacing counts made over the bridges to estimate tunnel capacity, the average or ordinary condition was used in making the computations. Upgrade movement determines the capacity of each line. The following were found to be representative figures for characteristic speed and spacing with continuous lines of vehicles operating on an upgrade for the various types of vehicles:

	Speed M.P.H.	Spacing, Feet, c. to c.	Capacity, Vehicles per hour, one direction
(1) Line of horse-drawn vehicles and slow moving trucks	3.0	33	180
(2) Line of slow-moving trucks (no horses)	5.0	42	630
(3) Line of motor trucks and pleasure cars	9.5	45	1,120
(4) Line of fast-moving motor trucks and pleasure cars	12.0	50	1,270

The average daily traffic, based on 24-hour counts made on the ferries, was 12.2 times the maximum hourly traffic. The total yearly traffic is computed from data furnished by the ferry companies which show the yearly traffic to be 340 times the average week-day traffic. The estimated capacities are as follows:



PLAN IV—CROSS-SECTION OF TWIN TUBES RECOMMENDED AFTER STUDY OF ELEVEN PLANS

ESTIMATED TUNNEL CAPACITIES

	Vehicles per Hour	Vehicles per Day	Vehicles per Year
One-Line Tunnel*:			
With horse-drawn and slow motor vehicles	960	11,700	3,980,000
With motor trucks and passenger cars	1,260	15,400	5,240,000
Two-Line Tunnel†:			
With horse-drawn and slow motor vehicles in one line and fast motor trucks and passenger cars in second line	3,200	39,000	13,270,000
With all motor vehicles in both lines	3,800	46,400	15,800,000
Three-Line Tunnel‡:			
With horse-drawn vehicles in one line and motor vehicles in two lines	5,250	64,000	21,800,000
With all motor vehicles in all three lines	6,040	73,600	25,000,000

*One line in each direction, i.e., two traffic streams.
†Two lines in each direction, i.e., four traffic streams.
‡Three lines in each direction, i.e., six traffic streams.

From the above figures it is seen that maximum hourly capacity of one tube of the recommended two-line tunnel (carrying a double line of traffic in one direction on a 20-ft. roadway) is 1,900 vehicles per hour.

The foregoing figures are for traffic in both directions and indicate that a one-line tunnel would have a capacity about equal to the traffic demand at the opening of the tunnel. A two-line tunnel would have sufficient capacity to accommodate all traffic of motor as well as horse-drawn

vehicles up to 1935, and if horses were eliminated during rush hours its capacity would not be reached until 1937; with horse-drawn and motor vehicle traffic the capacity of the three-line tunnel would be reached in 1943, and with all motor operation, in 1945.

In the discussion of the relative merits of roadways accommodating one, two and three lines of traffic, it has been claimed that the capacity of the road varies as the square of the number of lines of traffic, based upon the increased speed of each additional line. It was found in the traffic counts on the bridges that after a speed of from 10 to 12 mi. per hour is reached, any additional speed necessitates increased spacing for safe operation and does not increase materially the capacity of the line.

Economical Size of Tunnel

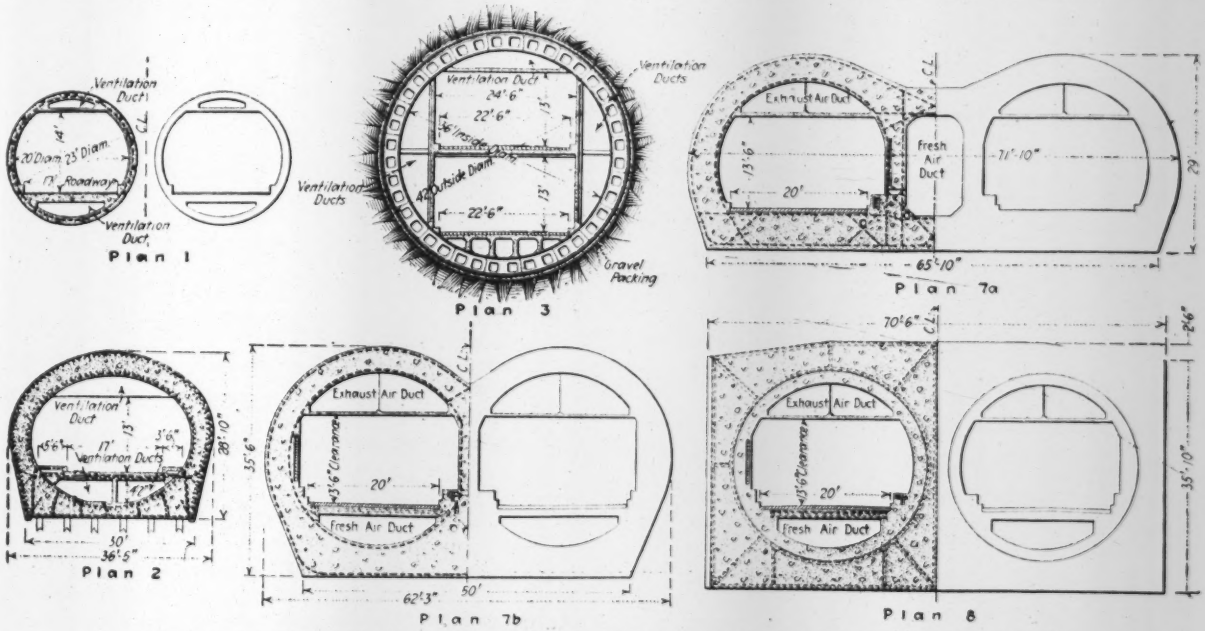
It would be unwise, according to the report, to build a tunnel to accommodate only one line of traffic in each direction as such a tunnel would be operated to its maximum capacity when first opened to traffic, with no allowance for growth of traffic. The choice, is, therefore, between either a two-line or a three-line tunnel. The principal points to consider in making this decision are those of economy and of traffic congestion in the vicinity of the tunnel entrances.

Considering economy, estimates of cost were prepared for both sizes of tunnels and it was found that the difference in cost between a three-line and a two-line tunnel, with interest, would be sufficient to pay for the construction of another two-line tunnel by the time the capacity of the two-line tunnel had been outgrown. In other words, if a three-line tunnel were built at the present time, "it would be overbuilding with a consequent spending of money for facilities which would not be utilized for a long period of time. The economic consideration is, therefore, decidedly in favor of a two-line tunnel."

The report also shows that the project for a three-line tunnel would create such extreme traffic congestion that it never could be operated to capacity. In other words, the three-line tunnel would be built and operated at a two-line capacity. The estimated capacity of the three-line tunnel, is 6,040 vehicles per hour in both directions, assuming that it can be "fed" with traffic. Taking half of this number and adding it to the 1,160 vehicles per hour at Canal and Varick Sts. in New York, gives a total of 4,180 vehicles per hour passing this point, *or nearly twice the number of vehicles on Fifth Ave. at the rush hour.* The congestion at the entrance of a three-line tunnel can best be visualized, the report states, by imagining all the East River bridges with their present traffic terminating in Manhattan *at one point.* No street in New York, the report concludes, could accommodate such a volume of traffic.

The construction of a tunnel of size and capacity greatly in excess of the requirements for the immediate future, the report continues, involving the expenditure of large sums of money, would be in direct violation of two of the main principles governing proper tunnel planning: (1) Distribution of traffic along the waterfront to avoid undue congestion and (2) the investment of capital for construction only as facilities are needed, without the necessity of making provision for the distant future. These points, it is stated, should not be lost sight of, as they are two of the most important features in which tunnel construction is superior to bridge construction in crossing wide navigable rivers.

The report, therefore, specifically recommends the construction of a two-line, instead of a three-line tunnel. The two-line tunnel, it is estimated, will have a capacity sufficient to accommodate traffic up to the year 1937.



THE MORE IMPORTANT OF THE TYPES OF TUNNEL STU DIED, BUT NOT RECOMMENDED

Dimensions of Vehicles and Headroom

Measurements were taken of vehicles crossing the Hudson River on the ferries between New York and New Jersey and it was found that their height varied from 6 ft. 6 in. for passenger cars to a maximum of 13 ft. for large, loaded trucks, but that the number exceeding 12 ft. in height was only 1 per cent. It was also found that the width of motor vehicles varied from 6 ft. for passenger cars and light trucks to a

maximum of 10 ft. 6 in. for army transport trucks. In the case of three-horse teams the outside dimension of the three horses abreast was found to be 9 ft., but the number of vehicles exceeding 8 ft. in width is only 3½ per cent.

Motor truck manufacturers, the report states, suggested 12 ft. 2 in. as the greatest distance between the road and the top of a truck body, and 8 ft. as the greatest width of the body. To provide for all contingencies, such as unevenness in the surface of the roadway, spring action of vehicles and allowances for jacking up in case of breakdown, the clear headroom of the tunnel was fixed at 13 ft. 6 in.

Width of Roadway

For a tunnel accommodating two lines of vehicles in the same direction on one roadway, the normal operating conditions may be considered to be that of one vehicle, 8 ft. wide, in the slow line and one, 6 ft. wide, in the fast line. It is to be expected, however, that at times there will be 8-ft. wide vehicles operating in both the slow line and the fast.

In the slow line of a two-line tunnel, vehicles operating at a speed from 3 to 6 mi. per hour should have a clearance of not less than 6 in. between the outside of the tire and the curb, while in the fast line, due to the greater speed, this clearance should be not less than 1 ft. If allowance is made for a minimum clearance between the moving vehicles of 1 ft. 9 in., the minimum width of roadway is 19 ft. For safe and convenient operation, however, a clearance between the moving vehicles of 2 ft. 9 in. should be provided, giving a 20-ft. width of roadway for two-line traffic, which is the width recommended.

Ventilation

The problem of ventilating the tunnel has been investigated under three main subdivisions: (1) Amount of composition of the exhaust gases from motor vehicles. (2) Dilution necessary to render these exhaust gases harmless. (3) Method and equipment necessary for adequate ventilation.

Investigation showed that there was comparatively little information available as to the percentage of carbon monoxide gas permissible in the atmosphere without injury to health. Air containing even minute quantities of carbon monoxide, if breathed for a long time, is highly injurious. With the co-operation of the U. S. Bureau of Mines tests were carried out to determine the amount and composition of exhaust gases from motor vehicles and the physiological effect of carbon monoxide on human beings and horses. The results, the report states, are to be made public at a later date.

The method of ventilation which appears best adapted to the Hudson vehicular tunnel is that of introducing fresh air through a number of openings leading from a fresh-air duct separated from the roadway (see cross-sectional drawing) and exhausting the vitiated air similarly through an exhaust duct. The proposed distance between ventilating shafts is 3,800 ft. The method proposed avoids excessive air velocities in the tunnel which would be caused by blowing fresh air from one portal to the other.

The question of the proper location of the fresh-air and exhaust ducts has been given consideration. Tests carried out by the Public Service Corporation of New Jersey in 1916, in a model tunnel section, showed that, with all doors and ventilator openings closed and no circulation of the atmosphere, the percentage of exhaust gases was greater at the floor, or near the plane of exhaust, than at the roof. However, when fresh air was introduced, the analyses showed that carbon monoxide was very much less in cases where the fresh air was introduced at the bottom and exhausted at the top than it was when this operation was reversed. The results appear to indicate, according to the report, that under conditions where the air in the inclosure is in motion, as would be the case in the tunnel, the exhaust gases tend to rise so rapidly that they cannot be exhausted as readily through openings at the roadway as through openings near the roof. Upon the basis of these tests the fresh-air duct has been located below the roadway and the exhaust duct above.

In discussing the cross-section of the air ducts, the report points out that the areas must be sufficient to insure low air velocities, thereby making possible an economical ventilating plant and not one required to operate at excessively high pressure, as would be the case if the ducts were small. The power required to ventilate the tunnel and consequently the operating costs vary inversely as the cube of the duct area.

Ventilating Shafts—The tunnel has been designed with four ventilating shafts, two of which (3,800 ft. apart) are located near the pierhead lines and the other two between these shafts and the portals. With this arrangement the cost of operation is reduced to about one-quarter of what it would be if the tunnel were provided with only two ventilating shafts at the bulkheads. All fans and motors are to be located in structures at the top of the ventilating shafts and will be of standard sizes.

The portion of the report dealing with ventilation concludes with the specific statement that in the opinion of the chief engineer, "there is absolutely no question as to the feasibility or practicability of ventilating the vehicular tunnel at a reasonable cost."

With a view to eliminating the need for artificial ventilation consideration was given to mechanical haulage of vehicles through the tunnel, including moving platforms, flat cars and hauling cables. All of the schemes, it was found, offered too many difficulties for practical application and all plans for mechanical haulage were rejected.

Types of Tunnel Considered

Before the 29-ft. twin-tube, cast-iron shield tunnel was recommended a detailed study was made of eleven different plans, proposed by various engineers since 1913, as follows:

Plan I—Twin cast-iron tubes (external diameter 23 ft.) to accommodate two lines of traffic in each direction with a 17-ft. roadway and no sidewalk and a clear headroom of 14 ft. A cross-section of this tunnel is shown, p. 361.

The maximum adverse grades were, east-bound 3.7 per cent, and west-bound 3 per cent. The estimated capacity of these tubes was 5,000,000 vehicles per annum, approximately the entire vehicular traffic crossing the Hudson River on the ferries at that time. The tubes were to be constructed with an outer lining of cast iron and an inner lining of concrete, similar to the Pennsylvania North River tunnels. The time required for construction was fixed at 3 years and the estimated cost was $11,000,000, which included the cost of easements, carrying charges, engineering and contingencies.

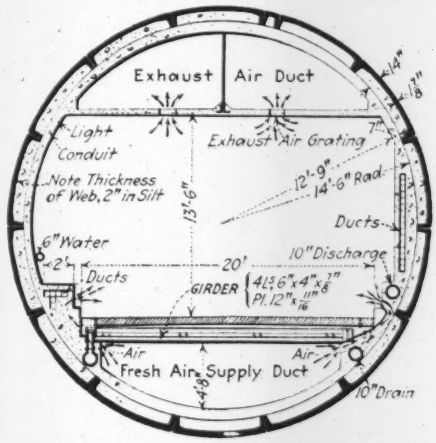
In recommending the construction of a pair of shield-

driven tubes, 23 ft. in diameter, the engineers advocating it followed a plan of construction which has already been successfully completed and there was, therefore, nothing speculative as to the feasibility or the success of the undertaking. From an investigation it appears that:

1. The capacity of the tunnel was considerably underestimated, probably due to the fact that in 1913 the increased use of the motor vehicle of today was not anticipated, so that the capacity was based on a larger volume of horse-drawn vehicles than is now the case.
2. The width of roadway is not sufficient for two lines of traffic under present conditions.
3. The tunnel cross-section is not sufficient to provide adequate ventilation.
4. The estimate of cost at the time it was made was probably sufficient, but now is entirely too low.

This plan is not recommend for adoption.

Plan II—A single pre-cast reinforced-concrete tunnel, 36 ft. 6 in. wide and 29 ft. high (external dimensions) to accommodate one line of traffic in each direction with a 17-ft. roadway and two sidewalks, 5 ft. 6 in. and 3 ft. 6 in.



SECTION OF ONE OF THE TWIN TUBES RECOMMENDED SHOWING VENTILATING DETAILS

wide respectively, and a clear headroom of 13 ft. A cross-section of this tunnel is shown, p. 361.

The maximum adverse grades were, east-bound 3.85 per cent and west-bound 4.55 per cent. The estimated capacity of this tunnel was 7,700,000 vehicles per annum.

It was recommended that this tunnel be constructed by the trench method and the plan of construction, although never before carried out, was considered by the engineers proposing it to be entirely feasible. The estimated cost of construction of the tunnel fully equipped with ventilating and electric lighting fixtures was $6,899,000, based on pre-war prices or $9,000,000 on prices prevailing in 1916, which included contractor's profit, engineering and contingencies. The time allowed for construction was 2 years. A study of this plan involved the consideration of several unknown factors and it was found that:

1. The capacity of the tunnel is inadequate to meet the present demands of traffic crossing the Hudson River.
2. The cross-section of the tunnel is sufficiently strong, but the difficulties of construction are dependent upon several unknown factors.
3. The estimated cost of construction is low and would have to be greatly increased under present-day conditions.
4. The time allowed for construction is less than would be required.

This plan is not recommended for adoption.

Plan III—A double-deck concrete block tunnel (external diameter 42 ft.), to accommodate three lines of traffic in each direction with two 22 ft. 6 in. roadways and no sidewalk and a clear headroom of 13 ft. A cross-section of this tunnel is shown, p. 361.

The maximum adverse grades were, east-bound 4.45 per cent and west-bound 4.13 per cent. The estimated capacity of this tunnel was 100,000 vehicles daily. The time required for construction was stated as 3 years and the cost was estimated to be $12,000,000 exclusive of land and easements.

The plan of construction as recommended differs radically from anything heretofore attempted by the shield method, not only in the great diameter of the tunnel but also in the type of lining. The departure from accepted practice was justified by the claim that it has great advantages over the methods heretofore employed. After a very careful investigation your engineer found that:

1. The capacity of the tunnel is overestimated, as the width of roadway is not sufficient for three lines of ordinary and usual traffic but is sufficient only for two lines of traffic and a 3-ft. sidewalk.
2. The lining of concrete blocks is not of sufficient strength to withstand the loads to which it would be subjected, and is not suited to Hudson River conditions.
3. The difficulties of construction would be enormously increased and the methods proposed to overcome them are undeveloped and do not insure the safe prosecution of the work.
4. The estimated cost of construction is too low.
5. The time for construction which was fixed at 3 years is very much less than would be required.

In view of the deficiencies and difficulties in this plan, without any apparent advantage over those which can be obtained by the construction of twin tunnels, your engineer recommends that it be not adopted.

Plan IV—Twin cast-iron tubes (external diameter 29 ft.) to accommodate two lines of traffic in each direction with a 20-ft. roadway and a 2-ft. sidewalk in each tube. The maximum adverse grade for west-bound traffic is 3.5 per cent and for east-bound traffic 3.52 per cent. A cross-section and location plan of this tunnel are shown, pp. 360 and 357.

The design of this tunnel follows closely that of the usual shield-driven subaqueous tunnel in that it consists of successive cast-iron rings bolted together with an inner lining of concrete. The experience obtained in driving other tunnels is applicable to this tunnel and it is certain that the methods heretofore used insure the successful completion of this plan of constructing.

This plan is recommended for adoption.

Plan V—Twin cast-iron tubes (external diameter 36 ft.) to accommodate three lines of traffic in each direction with a 27-ft. roadway and a 2-ft. sidewalk in each tube.

This plan is not recommended on account of the greatly increased cost and difficulties of construction as compared with the twin tubes 29 ft. in diameter.

Plans VIa, VIb, VIc—A pair of cast-iron tubes (external diameter 31 ft. 6 in.) with traffic facilities as follows:

(a) 22-ft. 6-in. roadway and a 2-ft. sidewalk.
(b) 24-ft. 6-in. roadway and no sidewalk.
(c) 20-ft. roadway and 4-ft. 6-in. sidewalk.

Plans VIa, VIb and VIc were studied in detail with a view to determining the greatest traffic facilities which could be provided in a tunnel 31 ft. 6 in. in external diameter. Plans VIa and VIb provide roadways which are too narrow for three lines of traffic and are wider than necessary for two lines of traffic, while Plan VIc provides for two lines of traffic and a 4-ft. 6-in. sidewalk.

It is recommended that none of these plans be adopted as the increased cost is at least 20 per cent more than that of Plan IV. This increase in cost is unwarranted in view of the slight increase in facilities provided.

Plans VIIa, VIIb—A pre-cast, reinforced-concrete tunnel with two 20-ft. roadways and sidewalks 2 ft. wide to accommodate two lines of traffic in each direction. Cross-sections of these tunnels are shown, p. 361.

The plans for construction follow closely those recommended to the Public Service Corporation in 1917, differing only in modifications deemed necessary to provide for greater traffic capacity. This method of construction has

never been used on the large scale proposed, but it appears that under favorable conditions its adoption might effect a saving in cost.

Plan VIII—A concrete tunnel with a steel shell and an outer protection of concrete placed by the tremie method with two 20-ft. roadways and sidewalks 2 ft. wide to accommodate two lines of traffic in each direction. A cross-section of this tunnel is shown, p. 361.

The plans for construction follow closely those successfully used under the Harlem River in New York City, and under the Detroit River from Detroit, Michigan, to Windsor, Canada. The latter tunnel was successfully carried out and more nearly approaches in magnitude the Hudson tunnel.

Plan Recommended

The 29-ft. cast-iron tubes recommended follow standard practice. They are to be constructed by bolting together successive rings of cast iron 2 ft. 6 in. wide. Each ring is made up of 14 segments, approximately 6 ft. long and a key 1 ft. long. In each ring there are 95 bolts on the circumferential joints and 75 bolts on the horizontal joints. The diameter of the bolts is 1⅛ in. The weight of the cast-iron lining through sand and part earth and part rock excavation is 8 tons per linear foot, while through the silt, in order to increase the weight of the tunnels, it is 8½ tons per linear foot. Inside the cast-iron lining there is an inner lining of concrete 19 in. thick, extending to a point 7 in. beyond the flanges of the rings. The surface of the concrete is to be rubbed and painted so as to provide a smooth surface which can be kept clean. The use of glazed tile was considered but it is not recommended on account of its cost. Other details are shown in the drawings.

The estimated cost of the tunnel structure only is $22,262,000, divided equally between the two states, and the time required for completion is 3½ years.

Equipment

Fans—The method of ventilating the tunnel provides for the installation of blower and exhaust fans at each of the ventilating shafts. To ventilate the tunnel when operated at its maximum capacity 65 fans, including spare units, are required.

Drainage—Adequate drainage facilities will be provided by the construction of sumps at the portals and at the low points in the tunnel. The portal sump will take all storm-water, while the tunnel sumps will collect all water from cleaning and leakage. The water will be caught in catch basins and conveyed by drains to the sumps, so that no polluted water can reach the lower air duct. Special provision will be made for the removal of oil collecting in the sumps. It is planned to have the pumps, with a capacity of 600 to 750 gal. per minute respectively, installed at the portal and river sumps. The pumps are to be motor driven and automatically controlled.

The estimated cost of equipment, including ventilating machinery, lighting fixtures, pumps, cables and shaft superstructures above the level of the street or dock floor is $705,000.

Administration, Maintenance and Operation

The charges for administration, maintenance and operation of the tunnel after its completion includes general overhead and office expenses, the collection of tolls, policing, cleaning, depreciation and maintenance of the ventilation, lighting and pumping equipment, buildings and pavements, and supplies which vary from $254,000 per year at the time of opening to $314,000 per year at time of capacity of operation. These figures do not include the cost of power for lighting, pumping and ventilation, which varies from $31,000 at the time of opening of the tunnel to $301,000 per year when the tunnel is operated at full capacity with all motor vehicles.

For the purpose of arriving at an estimate of income, the revenue from ducts is fixed at $2,000 per duct per annum.

Traffic Rates—The amount of revenue from vehicular traffic over the ferries during the days on which traffic counts were made shows that the average fare for horse-drawn vehicles was 25c. and for motor vehicles, 41c. The average charge for motor vehicles in the immediate future will be at least 45c. and for horse-drawn vehicles, 20c. These rates have been adopted not only as the charge for traffic at the time of opening the tunnel, but also throughout the following 20 years. It is considered that an estimate of revenue based on the preceding rates will prove to be conservative.

Financial Considerations

The total estimated cost of the tunnel recommended, as defined in the contract between the states, is as follows:

ESTIMATE OF COST

Tunnel Construction, based on present-day prices for labor and materials, with an allowance for contractor's contingencies and profit	$22,262,000
Equipment	705,000
Engineering, in which is included design, supervision and inspection, estimated at 6 per cent of the cost of construction and equipment	1,378,000
Administration, including office rent, salaries and expenses of the clerical staff of the Commissions, estimated at 2 per cent of the cost of construction and equipment	459,000
Total	$24,804,000
Real Estate and Easements, net cost (refer to p. 47)	2,500,000
Total	$27,304,000
Contingencies, to provide for fluctuations in the cost of labor, materials, claims, accidents, etc., estimated at 5 per cent of above total	1,365,000
Total cost of project	$28,669,000

Each state's share of the estimated cost of the tunnel as given above amounts to $14,335,000, and in order to determine the probable time of amortizing the cost, a financial statement was prepared, covering a period of 20 years, which gives by years the estimated revenue, operating charges, net income, bonds retired in $50,000 lots on the basis of a serial bond issue and a surplus accruing to each state.

From the financial statement it appears that the cost of the tunnel would be amortized in 11 years and at the end of a 20-year period there would be a surplus to each state amounting to $33,635,000, in addition to having a tunnel without cost to the people.

In presenting the statement showing the financial soundness of the undertaking, the chief engineer emphasizes that this great public improvement, so necessary for the proper conduct and development of the business between the two states and in the Port of New York, can be constructed and maintained without question, on a self-supporting basis, with a very considerable surplus.

In conclusion Mr. Holland records his indebtedness for valuable services rendered by the members of his engineering staff, particularly Jesse B. Snow, principal assistant engineer; Milton H. Freeman, resident engineer, and Ole Singstad, designing engineer, and for the hearty co-operation and advice of the Board of Consulting Engineers.

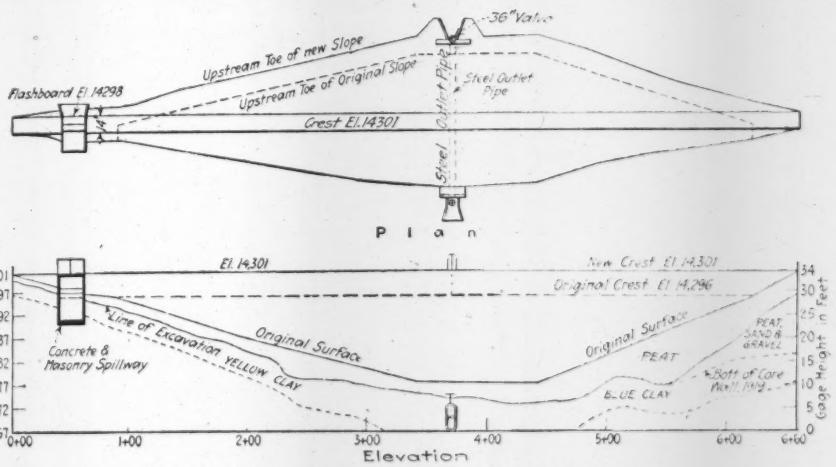
Clay Blanket Stops Leakage in Earth Dam

Covering Is Placed on Upstream Face of South American Earth Fill and Dam Raised 5 Ft. at Same Time

By B. E. Torpen
Resident Engineer, Cerro de Pasco Copper Corporation, Morococha, Peru

LEAKAGE in a gravelly earth dam built by the Cerro de Pasco Corporation in the mountains of Peru was stopped last year by blanketing the entire face of the dam with clay to the thickness of about 3 ft. On account of the remoteness of the site and the type of labor the operations had some novelty.

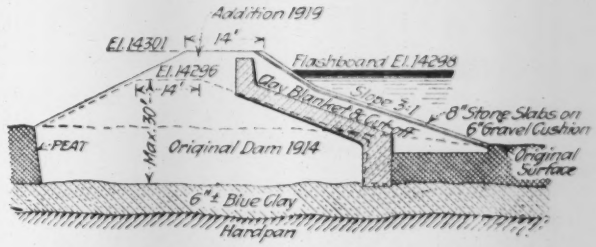
In 1913 the corporation built an earth dam at the outlet of Lake Huascacocha which raised the waters of the lake about 20-ft. and made available 6,400 acre-feet of storage for power purposes. This dam had an over-all length of 550 ft., a maximum height of 30 ft., a crest width of 14 ft. with upstream slope of 3:1, covered with riprap, and a downstream slope of 2:1.



PLAN AND ELEVATION OF PERUVIAN EARTH DAM

The material available was of a very gravelly nature and, although carefully built, the dam showed considerable leakage as the water raised in the reservoir and became wholly saturated below the water line. Three or four leaks as large as one's finger were developed and the north half of the dam settled 12 to 18 in. in five years. Being a menace to the safety of property below, it was decided to repair the dam by the addition of a clay blanket to the upstream face and to place in front of the clay an equal layer of earth to hold the clay in place. On this earth it was decided to place paving as before on a 3 to 1 slope. The crest of the dam was also to be raised 5 ft.

Lake Huascacocha is in an isolated region on the headwaters of the Amazon at an elevation of 14,300 ft. in the Andes Mountains, 80 miles inland from Lima. This necessitated the work being done by pick and shovel method. The native Indian laborers were paid



DETAILS OF SMALL PERUVIAN EARTH DAM BLANKETED AGAINST LEAKAGE

S. 1.80 or 90c. per 8-hr. day. The clay was all delivered in wheelbarrows, but a 20-lb. narrow-gage with two 1½-yd. home-made cars, gravity operated, delivered earth from a borrow pit 500 ft. distant.

The work was begun about Dec. 1, 1918, at the end of the dry season, as then the reservoir was empty. First of all the riprap was removed and along the toe of the dam a cutoff trench 5 ft. wide, and varying in depth from 4 to 16 ft., was excavated through the peat overburden into the impervious clay underneath the dam. This was carefully backfilled with selected clay well rammed into place. Clay was also carried up the upstream slope, forming an impervious blanket about 3 ft. thick, thus insuring water-tightness. The sod and surface soil were excavated to the new slope lines and a layer of earth 3 to 4 ft. thick placed in front of the clay to hold it in place.

The new face was riprapped or paved with flat slabs of limestone of 1 to 10 sq.ft. area, 6 to 10 in. thick, placed on a 6-in. layer of gravel. The gravel was delivered to the job by llamas, from a pit 2 km. distant at a cost of 6c. gold per sq.yd.

Wheeling clay over soft ground in rainy weather

FILLING TOE CUT OFF TRENCH WITH CLAY

LLAMAS USED TO CARRY GRAVEL TO DAM

was doubly difficult, because the laborers wear crude sandals of cowhide and were constantly slipping. Their efficiency was practically doubled by laying on the soft ground a runway of 20-lb. rail, laid on the side and end to end so the wheel of the barrow traveled in the groove. In this manner the wheelbarrows could not jump the track and had a solid bearing throughout. The clay layer was placed in 3- or 4-in. layers wetted and thoroughly hand tamped. Being very soft, a good bond was secured throughout and the passage of water made practically impossible at the heads encountered. The earth front was of similar thickness and carefully placed. As the work progressed the water was raised in the reservoir to store the heavy run-off and the water level was always close to the work.

The dam crest was raised 5 ft. and when completed, May 1, 1919, the water stood 5 ft. higher than before and no leakage was apparent through the dam.

Field costs were as follows:

2,950 sq.yd. stone riprap cost $0.15 per sq.yd. incl. gravel.
3,000 cu.yd. clay fill cost $1.50 per cu.yd. in place.
1,500 cu.yd. earth fill cost $1.05 per cu.yd. in place.
1,800 cu.yd. excavation cost $0.80 per cu.yd.

The total expenditure on the work and the distribution of same were as follows:

		Per Cent
Labor	$ 27,389	83.3
Material and equipment	2,764	8.4
Engineering and superintendance	2,732	8.3
	$ 32,885 = $15,950 = $6.12 per acre-foot	

Aside from repairing the old dam and making it safe, this work provided for an additional 2,600 acre-feet of storage. Passing through two power plants with a total drop of 1,500 ft. this water has a yearly value of $3 per acre-foot, or $7,800 represents the yearly value of the job, which will pay for itself in two years.

F. G. Baum, San Francisco, Cal., is consulting hydro-electric engineer; E. S. Kalenborn, Oroya, Peru, is engineer and superintendent of power; and the writer was resident engineer in charge of construction.

Sludge Utilization at Kingston-on-Thames

Continuation by the town of Kingston-on-Thames, England, of the utilization of sewage sludge formerly carried on by a company was under consideration in January, 1920, according to the London *Surveyor*. For a number of years a private company produced "native guano" at the sewage works by means of the "A.B.C." process [precipitation of alum, blood, charcoal and clay.—EDITOR]. Since the original contract ended the works have been operated by the town, and the pressed sludge supplied to the company without charge.

Engineer's Responsibility in Social Problems

Extracts from the Presidential Address of Lieut.-Col. R. W. Leonard Before the Engineering Institute of Canada

"SOUND economic doctrine is just as much the foundation of the engineer's professional education as mathematics and physics."

This sentence may be taken as the key-note of the first half of the presidential address of Lieut.-Col. R. W. Leonard, retiring president of the Engineering Institute of Canada, before the annual meeting of the Institute at Montreal, Jan. 27. He went on to make an analysis of the causes of industrial unrest and pointed out that the engineer whose training and life work are devoted to the study and solving of practical problems is best fitted to find workable solutions.

The latter half of the address was devoted to a review of the work of the Engineering Institute of Canada during 1919 and to comment upon recent engineering developments both in Canada and abroad. This part of the address, on account of lack of space, is omitted here.

The following extracts are from that portion of Colonel Leonard's address which discusses the responsibility of the engineer in social problems:

FUNDAMENTALS OF OUR CIVILIZATION

A few years ago it would have been unnecessary to deal with the fundamentals of our civilization; they were so imbued in our beings that it was almost silly to formulate them into words. We rested securely in the belief that "Truth is might and will prevail." Of late, however, so much false teaching and distortion of fundamental truths has been disseminated, and accepted by so many, that downtrodden Truth would appear to need the assistance of some Minister of Propaganda if she is to hold her place and prevail before the structure of our civilization is badly shaken. Sound economic doctrine is just as much the foundation of the engineer's professional education as mathematics and physics.

We have the much-taught doctrine that "all men are born equal," which is an obvious fallacy. It is a self-evident fact that there is as great natural inequality—physically and mentally—in the different branches of the human race as in any other species of the animal kingdom. This difference, greatly increased by the moral and spiritual inequalities of the human race, is influenced again and emphasized by environment and education from the cradle to the grave. The very men who ignorantly preach that one man is as able as another and as well qualified to rule or hold office—that race and family count for naught—will spare no pains, in breeding his live stock to select parents having certain desired characteristics of disposition and physique.

G. F. Swain, late president of the American Society of Civil Engineers, in his address at their Ottawa Convention in 1913, made the following remarks:

"Equality of condition means pauperism or savagery; the inequality of man means the division of labor, progress and civilization.

"We should encourage the recognition and admiration of superiority.

"We should preach the gospel of content instead of discontent. 'Do violence to no man, neither exact anything wrongfully; and be content with your wages,' said John the Baptist. There are two kinds of discontent, one praiseworthy; one ignoble. The former springs from a laudable ambition, and a desire to perfect oneself so far as natural endowment will permit. The other springs from envy and the desire to reap the rewards of the industry of others. The former kind of discontent is to be encouraged; every

man should be given an opportunity to develop himself and to be confirmed in the possession of the prizes which he may gain; but the discontent which springs from envy, which leads men to depend on Government help instead of self-help, which sanctions forms of unjust taxation which may be nothing less than legalized robbery, should, in every possible way, be repressed. The attention of men, instead of being concentrated on what they want, should be directed to a realization of what they have. In contrast with the conditions which existed one or two centuries ago, even the conditions of the poorest classes at the present time are immensely improved. Yet with all the reduction in working hours that has taken place in the last fifty years, and the other improvements in conditions, I doubt if there is any more real happiness and content among the poorer classes. Nor have I any doubt that the excessive talk about bettering the condition of the working classes blinds them to the opportunities for their own thrift and industry."

When I begin to quote Mr. Swain's very notable address I scarcely know where to stop. I commend it all to you as a splendid example of a well-reasoned statement of social conditions which does justice to the disciplined and trained mind of the educated engineer.

The value of such expedients as old age pensions, unemployment insurance, etc., may be overestimated, as they must tend to increase a spirit of irresponsibility and extravagance, to lessen the incentive to thrift, to encourage carelessness in quality of work performed, and to reduce the sense of filial responsibility. Such results do not tend to advance our civilization. "The hand of the diligent shall bear rule, but the slothful shall be under tribute."—Proverbs XIII, 24.

Rewards for Effort

A popular cry of the ignorant, uneducated "socialist" is: "Why should the many support the few?" All thinking men know that it is the few who have the energy, intelligence, courage and enterprise to overcome the great natural obstacles that frequently lie in the road to success—to explore the unknown wastes of the earth and make them accessible to man, and to delve into the hidden resources of nature, geographical, geological, physical and chemical, and force her to yield up her undiscovered secrets, and who, through their natural and acquired ability to develop and harness nature's great resources to serve the needs of man, are creating industry and the benefits of industry for the great masses of the people. We realize now in greater measure than ever before that the labor of the explorer, the inventor, the organizer, the manager and the skilled and unskilled workman is most urgently required to restore the world's wealth, wasted in war, and to build up again a well-balanced economic and social structure. Achievement along such lines is deserving of honor and distinction, and of the wealth which properly accrues from such accomplishments, for these rewards constitute the foundation stones of the arch of civilization, just as industry, integrity and thrift form the arch stones. It was the tearing out of these arch stones that was largely responsible for the fall of the ancient civilizations of Greece and Rome; it is the tearing away of the foundation stones that has caused the utter collapse of Russia, as we see her today. . . . .

The foundation stones may be popularly (though loosely and incorrectly) described as "Capital" and the arch stones as "Labor." Each is dependent on the other. I say "may be popularly described," because every man who possesses a constructive mind or owns one dollar's worth of any useful commodity or one dollar in money, is a capitalist; and every man who works, mentally or physically, is a laborer. But the man upon whose work of eight or ten hours per day depends the well-being of himself and those dependent upon him only, cannot be counted of the same value to society as the one upon whose enterprise, ability and industry depends the well-being of a factory full of employees and their families by maintaining the factory in continuous operation on a profitable basis. . . . .

Labor unrest is largely the result of failure or refusal to recognize such facts and conditions as fundamentally right. The workers are led, by observation of occasional large returns upon capital (always featured in our newspapers with sensational head-lines) to ignore the risk and more frequent losses incident to industry—(hidden in very small print, if mentioned at all). The taxation of excess profits has incited the worker to seek a share in these profits, while overlooking the logical conclusion that they would necessarily require also to share in the losses, as it is difficult to understand how partnership in industry can long exist without joint distribution of the risks as well as the rewards.

Occasionally one hears of apparent success in some scheme of profit-sharing, joint industrial councils or suggestion of "sweating the machinery instead of the men," and doubtless there are some industries to which such schemes can be adapted so long as the results of operation are profitable. In the event of losses, however (if only over a short period of time), I fear that the system would not long survive such treatment. I defy any engineer to tell me how to "sweat" a pick and shovel without some measure of perspiration on the part of the wielder thereof.

As ability to understand what, to him, are the intricacies of business as applied to profit-sharing, etc., is absolutely essential to the success of such schemes, and as practically the only education these men receive in this direction is such as is instilled into them by agitators who find fomenting industrial strife a much pleasanter occupation than working for a living, the prospects for the general successful adoption of these innovations is not bright.

If solutions are possible whereby the lot of the working man can be improved, the engineer—whose training and life-work are devoted to the solution of practical problems—is most capable of finding them.

Engineers know, as well as the intelligent workmen, how fictitious are most of the alleged grievances in many of the recent strikes. These workmen, perhaps, are not to be too severely criticized if they are content to accept any immediate advantage that may be secured by means of some temporary trouble. The frequent argument that "If all vote for a strike there won't be any" is very seductive.

Leadership

All mankind tends to crystallize into tribes or factions under a leader. Sometimes the employer, by his strength of character or fair dealings, commends himself to the employees as a leader, and in such cases there is seldom serious labor troubles. Lacking this condition the men select their own leaders and—as frequently in democracies—the selection is not always of the wisest or most moderate man. This leader in order to justify himself works day and night and Sundays to find trouble, in the solution of which he can demonstrate his fitness for the job.

Until the wise heads in the Unions get together, take control and educate the others along lines of duty and honest service to their fellowmen, there can be no industrial peace.

The present tendency appears to be toward the obtaining of special legislation and privileges for highly organized bodies of labor beyond its proportional value, which, if continued, must result in the eventual extinction of the particular union, trade or business involved, just as the trade guilds of the Middle Ages perished, and as the stone-cutter's trade dwindled when concrete took the place of cut stone. A striking example is the headway that the use of concrete is making for house-building in England as a result of the "ca-canny" of the Bricklayers' Unions, which is largely responsible for the increased cost, and, therefore, the rent, of the laborer's cottage.

W. R. Ingalls [formerly editor of *Engineering and Mining Journal*], in an admirable address before the Canadian Mining Institute in May last, cites the case very clearly, as follows:

"It was the theory of Karl Marx, from whose teachings are derived so many of the fallacies of the present time, that labor, in its narrowest sense, produces everything, and, therefore that labor should have all that it produces. That idea is frequently expressed now all over the world. We

have already seen that labor gets almost all as it is, and what remains it would not get, for if profits for example are the reward of intelligence, the removal of intelligence would remove profits also. So long as the world was dependent upon mere man-power there was no very great advance in the wealth of nations beyond what was due to increase in population. There is no good reason to believe that an Englishmen in the reign of George V could carry any more weight per hour or for any more hours, or could exhibit any other superiority of physical power than an Englishman in the time of William the Conqueror. The great increase in production has happened during the last century and a quarter, and has not been because men have grown any stronger, but because mind has taught labor how to become more effective and has provided it with machines and with organization. It is the minds of the captains that have produced the great increase in wealth and to those captains might reasonably have accrued all that they earned, but the economic principle that labor is the residual claimant prevented any such result, even if it were desired. The income of England in 1801 was about £180,000,000. The income of the United Kingdom, at the same rate but allowing for the increase in population, in 1907, would have been about £900,000,000. Actually it was about £1,950,000,000, excluding the revenue from foreign investments. In the words of Mallock 'the mind of the larger employers was the primary producer of an income of some £1,050,600,000 added to an income that would otherwise have been £900,000,000 only.' Then he shows conclusively that of this increment the representatives of Mind got only about £250,000,000 for themselves, including both profits and the interest on industrial capital.

"I have shown I hope that there cannot be anything essentially wrong in the existing system of the distribution of the product of industry as between labor and capital. Labor cannot divide among itself any more than there is to divide, i.e., the total of what is produced. That is self-evident. It may attempt to seize the modest share of capital, but if it succeeds in doing so, that share dries up. If it confiscates capital itself it does not gain anything, for capital, without the directing minds to use it productively, ceases to be of advantage to anybody. The experiences in Mexico and Russia have shown what happens. The Bolshevists of other countries will lead to the same end if they have their way. Why is it that while socialists are shouting from soap-boxes, inflaming the populace with irritant poisons, while doctrinaires who hold professional chairs are issuing fallacies, while a motley crowd in Russia is performing the most cruel and disastrous experiment ever known, we cannot drive into the heads of people that even as things are under the capitalistic system they get all they can, that they can get no more than they produce, and that it is not the power of the mass but rather the minds of the few that have uplifted them to the stage of comfort that they enjoy today, which is vastly superior to what it was a century ago. If the Marxian doctrine has been true labor would be paid now what it was 100 years ago, no more.

"It is of profound importance to make the millions of workers see things correctly, for they are blindly approaching a time when adverse economic conditions are going to drive them, and no socialistic rantings or paternalistic policies by the Government are going to help them. The world has become so much poorer by the squandering of wealth and man-power during the war that no advance in the scale of living is to be expected from it. The prospect is just the reverse. The farmer does not lose his cattle and install improvements in his house because of his loss. The people of a city do not become profligate buyers of automobiles after a conflagration has swept away their houses. No more do nations become prosperous because war has consumed their substance. Instead of labor holding what it has gained during the war it is probable that it will suffer a relapse to a condition inferior to what it held just before the war, although the Unions will struggle bravely against it. Fortunately, we shall not see a loss of economic improvements, such as safety measures in industry, the provision of proper working quarters and conditions, because they are economic; but labor is in danger of losing the eight-hour day for the simple reason that it will have to work nine to ten hours in order to produce enough on which to live."

Responsibilities in a Democracy

During the progress of the war, in order to differentiate in a popular way the aims of the belligerents, the word "Democracy" became almost a war-cry, like "Remember the Maine" in the Spanish-American War. Both cries served their purpose. "Democracy" is defined as "the form of Government in which sovereignty of the State is vested in the people, or indirectly, by means of representative institutions."

It is the ideal form of Government where "the people" are intelligent and educated on sound principles. If, on the other hand, the majority of the voters—the ruling class—are ignorant, badly led or imbued with false political doctrines, it means the downfall of that State. Lenine is credited with stating that, of every one hundred of his followers, one is a Bolshevik, thirty-nine are criminals and sixty are fools. We see the result in Russia today—the most terrible famine and misery that a white nation has probably ever experienced, certainly since the Thirty Years' War.

The combinations of various classes of workmen into trades unions has undoubtedly been the means of bettering the living conditions and wages of the members, by bringing to the attention of the public the defects in those conditions. These successes have naturally led enthusiastic members to aspire to greater things, until the public who are neither employers or employees in the union sense feel that the limit has been passed, and that, in many cases, the power of the unions is being exercised unwisely and selfishly.

The hope for further progress in trade unions appears to depend on the ability of their leaders to recognize the necessity of instilling sound knowledge into their memberships, with a sense of their duties and responsibilities to the public as well as their rights. These duties include increasing efficiency with increasing pay and decreasing hours of labor. Otherwise, there is no limit to the high cost of living which, in the last analysis, depends largely on the high cost of loafing. Co-operation among all classes and nations there must be if we are to escape the downfall of civilization.

Water Power Shows Gain

The Division of Power Resources, United States Geological Survey, has published figures showing the production of electric power by the public-utility plants of the United States. The report, covering February, March, and April, 1919, was based on returns from about 3100 electric power plants engaged in public service and including central stations, electric railway and certain other plants whose output contributed to the public supply. The statistics show the relative output from plants operated by fuel and by water power. The total production of electric power, in thousands of kilowatt-hours, was as follows: February, 2,983,121; March, 3,150,166; April, 3,026,361. The average daily output, in thousands of kilowatt-hours, was as follows: February, 106,540; March, 101,620; April, 100,800. In February nearly 39% of the total was produced by water power; in March it had increased to 42%, and in April to 43%. The average monthly consumption of coal by public-service plants during the period was 2,815,000 tons, or 95,000 tons per day, an equivalent of 2100 carloads of 45 tons each per day. Of that coal consumption 39% was in New England, New York, New Jersey and Pennsylvania. In addition to the coal used to produce about 59% of all public-service electric power, there was also consumed a monthly average of 668,853 bbl. of petroleum or its derivatives and 1,703,788 cu.ft. of natural gas.

Canadian Demands in Engineering Education

Extracts From the Inaugural Address of Brig.-Gen. C. H. Mitchell as Dean of the Engineering Faculty of the University of Toronto

CANADIAN demand for engineers has changed in recent years, partly because of the war. While the number of civil engineering students formerly exceeded that in other engineering courses at the University of Toronto, that course, in numbers, now occupies third place. The specialties concerned with the industries have come to the front. These conditions were pointed out by Brig.-Gen. C. H. Mitchell, C.B., C.M.G., D.S.O., in his inaugural address as dean of the Faculty of Applied Science and Engineering at the University of Toronto last October. He discussed also the character of training which now must be given to young engineers, and outlined the extension of curricula planned at Toronto.

The following extracts are taken from his address:

Changes in Canadian Engineering

If we are to study for a few moments the trend of the great engineering activities of the country as they appeared firstly, before the war, compared with the period of the war; and secondly, during the war as compared with the future and its prospects of reconstruction activities, we find divergent differences. The activities have passed through various stages. It will be remembered that the prominent features of these activities before the war were connected mainly with the huge railway construction and extensions. Further activities included other features of transportation, of canals and terminals, then of hydro-electric power developments and a definite trend just previous to the war to comprehensive programs of large building construction connected with the expansion of manufacturing and commerce. This period too claimed a lengthy activity in mining and its allied industries.

The war changed all that; through the same sudden transition by which we passed from peace to war we almost as suddenly passed from the stages just described to the stages consequent upon the national mobilization of all our resources, and with that came an entirely different character of engineering activity. It resolved itself into the transformation of most of our great manufactories into munition works or works solely engaged upon war material, while the remainder, and many new ones, had perforce to continue in the work of carrying on the normal industries for the life of the country carried on with redoubled energy. Thus all the great public works of state or municipality were either hurriedly completed or abandoned for the time being.

In the same manner the sudden termination of the war from its greatest intensity to an unexpected armistice brought about a similar transition in the opposite direction. With the difference, however, that the great public works have not been resumed and if one may be bold to forecast, it is unlikely that they will be for some time to come in so far as railway construction is concerned.

But what does appear on the horizon, as the future of these great activities of the country indicates, is a large resumption of manufacturing and industrial work through the return to peaceful pursuits and the consequent readjustment of all that pertains to the life of a newly developed manufacturing country in which, as always, the agricultural industry is, and will be, the mainstay. But there is more than that; all those smaller public works and those smaller private enterprises which were arrested or dislocated during the war and which are not yet ready to be prosecuted or financed are still to be revived and within a few years will doubtless absorb the attention and services of many engineers, as well as the interest of the financiers of the country. This is all without any reference to the entirely new enterprises consequent upon the normal growth and development of the country such as was steadily proceeding previous to the war. Already there are signs of the resumption of this growth and it remains still to be seen whether this will take on the same form as previously in national or municipal public works, in mining and metallurgical progress, and in all those scattered activities where the services of the applied scientist and the engineer are called into use.

Trend of Engineering Training

Translating these considerations into terms of the needful scientific education to meet the requirements, and analyzing these requirements in view of the necessary leadership which, as has already been said, the University must exercise, it is reasonably certain that a reversal of the requirements has taken place and should be provided for. In short, where before the war the various branches of civil engineering stood pre-eminently first in the requirements, its relative demand in Canada, for the immediate future at any rate, has apparently fallen to second or perhaps third place in the grouping. The industrial group of engineering has come to the front and hence we find electrical, mechanical and chemical engineering high up in the group. In fact it is a curious feature that of the present first year in this Faculty numbering about four hundred in all of the eight departments, practically one quarter are proceeding in chemical engineering; this is undoubtedly a direct outcome and influence of the war. The mining group, including metallurgy, appears likely to follow a normal expansion for some years to come, although the actual increase in activity in mining not only in Ontario but throughout Canada has been somewhat arrested by the war, except in those directions actually influenced by munition production. In the more aesthetic side of applied science—that of architecture, town planning, and the like—who can say what the future may bring? It is difficult to forete[illegible] and to foresee what course the educational requirements of the country may take, although after all much depends on the extent to which the university offers attractions in this much discussed branch of scientific and artistic education—in other words it is for the university to offer influence and make the demand for architectural education and thus indirectly have an influence on the architecture of the country.

Having thus examined the course of the various branches of engineering and analyzed the tendencies and probabilities for the immediate future, it is necessary to see wherein the applied science and engineering education, as it has been and is now constituted in this country, is designed to meet the requirements of the times.

To appreciate properly the relation of the demand and supply of scientific education, if we may use such terms, it is necessary to first go back and consider the historic evolution of applied science and engineering in this and some of the other older universities on this continent. In doing so it is curious to find how, within limits, the university or college education has endeavored to meet the requirements of the particular period in the country's development. Forty years ago—and engineering in this University of Toronto under the old School of Practical Science dates back to that period—it was wholly civil engineering and was designed to meet a demand mainly for those public works which were necessary to the growth of the country at that time. Thirty years ago, a critical period in the development, a departure had been made, increasing or varying the courses to include mechanical and electrical engineering, architecture and chemistry.

In the intervening years a steady increase of the departments other than civil has taken place, and we now find that after various cycles of influences the industrial groups have come rapidly to the front and even dominate the whole Faculty. This is but a reflection of the normal development of the country, and is after all, what was to be expected.

General Mitchell then proceeded to discuss the phases through which the process of teaching applied science

has passed, pointing out that in many schools there was a wave of specialization which carried too far. Now there is the inevitable readjustment and return to the sound basis of thorough teaching of mathematics, physics, chemistry and descriptive geometry before the teaching of applied science itself. He then continued:

Requirements in Technical Education

Reverting to the great fundamental principles of applied science education it must be accepted that the first requisite is, without question, a sound general education as a foundation. This principle has already been put into practical application in this university by the establishment of more comprehensive and more stringent requirements at matriculation, whereby not only a very high standard is required in mathematics (senior matriculation), but high standing is also necessary in English and languages. But that is only the start and does not by any means insure all those fundamentals which form the foundation for the proper education of the applied scientist or engineer.

Following this further and considering the entire education of the young engineer, there seems only one conclusion as to the necessity of today in this young country at its critical stages of development. For now-a-days we require not only technologists in the form of applied scientists or engineers, but we want men who are more, much more than that, we require to produce men who by their college education will be:

1. Broadly educated, cultured gentlemen.
2. Good citizens of Canada and leaders of influence within the community in which they may be placed.
3. Thoroughly educated technologists in whatever branch of applied science they may choose to enter.

How best to produce this type of rounded out graduate in the four short years in which he is under the influence of his professors and instructors is open to much discussion, and time does not permit to follow it through. It is obvious, however, that if a university education does nothing else, it ought to produce a broadly educated, well informed citizen, capable of thinking for himself on all public questions and taking his part in leadership and genuine public service—all this apart entirely from the necessary special education and the application of it to his gaining a livelihood in the practice of his chosen profession. If then in coming up to the university to obtain his education, he must devote himself to his professional course in applied science, that course and that Faculty must provide him with his education in its entirety and must, therefore, not limit itself solely to the technological side of it.

At the other end of the scale of his education the young engineer of today who is not to be overspecialized must learn to think in terms of subjects and educational values which may prove of the most use to him on going down from the university and entering his professional life. True, it has been said he must have been grounded in the fundamentals, and in the practical application of these to the varied problems in the many sided phases of applied science as it is today known and practiced. But there is a further distance he must go, especially in these days of materialism and of what is known in the work-a-day world as "practical results." He must learn to orient his technical education with the economics of the world into which he is about to enter, so that he may the more readily become the thinker, the leader, and the actor in the great effort of development and service in which he engages. Herein lies what, in a few years, will be found to be one of the governing factors in the more detailed and special education of the young engineer—his place in the economics of the community. It can easily be said that in the four years of a college course but little time can be given to this phase of education; that is agreed, but it is possible to instruct and to combine the types of work in such manner as to keep these principles of engineering economics clearly before the student in his later years.

All this leads up to the consideration of the curriculum and the manner and extent of instruction which is best suited for the country for the period in which we find ourselves and for the general type of student who comes to this university for his education. The curriculum throughout all engineering colleges, especially on this continent, is in the process of change for the reasons already referred to and a study of the tendencies in those changes reveals a degree of uniformity which in a measure applies to the particular requirements of this country and this university. During my visit the past spring to nine of the leading universities in Great Britain where applied science is prominent, I was struck by the efforts that were being made to transform and reconstruct the curriculum in accordance with the newer demands, efforts which were due to the same causes and tendencies in the national life with which we ourselves are now confronted.

If the signs and the tendencies can be sensibly interpreted—and this appears to be a universal opinion today among not only those engaged in engineering education but in practice as well—there are several radical changes in the curriculum which are now opportune, indeed are demanded. Among these are proposed:

(1) A rearrangement of subjects and economy of time by avoiding crowding the curriculum with less essential subjects and by judicious sequence, to limit the number of subjects simultaneously studied to less than is now usual although not decreasing the number of student hours per week; (2) the introduction of broader humanistic subjects in the first two years which may be termed the general educational portion of the course, including, in addition to all the mathematics and science, a further study of English with special reference to applied science, and the introduction of studies in economics, sociology, and possibly logic and psychology in a form applicable to this work. This is without reference to the continuation of the study of modern languages which are so essential in the technical world of today; (3) the inclusion in the last two years of some of the higher forms of these broad subjects but with special application to the work and the relationship of the graduate after he enters his professional life; these subjects may be such as finance, engineering law and jurisprudence, commercial engineering, industrial management, and engineering economics, and it may be of interest to note here that some of this work in its simpler form has been included in the curriculum of this faculty for some time past.

In addition to the foregoing there seem to be various other considerations. For instance, the student has great difficulty in his early years in orienting himself to the objects and processes of study in applied science, in discovering the relative value of the various subjects he is put to study and in realizing the application of these subjects to the real business of engineering practice.

Much stress is laid by British and American universities on the inclusion of what they call practical engineering work side by side with the theoretical work in the earlier years. This was clearly recognized in this university in the early curriculum of the School of Practical Science and has been a feature ever since—for instance, the laboratory work helps out the lectures in electricity and mechanics and surveying helps out the mathematics. In addition to this our curriculum here has always made it an essential that the student engage in some actual practical employment in the field and in engineering works during the summer holiday, lengthened specially for this purpose, and a new departure is now made by the establishment of a large rural camp or school about thirty miles north of Toronto for the purpose of carrying on instruction in surveying independent of that experience to be gained in the ordinary manner. The general tendency now, and one to be encouraged in connection with the education of the electrical, mechanical, or chemical engineer, is to participate in real industrial work, not only through the summer holiday period, but in some form of continuous co-operation with industries. Such work should be supervised to some extent by the college, and used as a source of problems and projects for scientific analysis and study and can be made mutually useful to the industry and the student. I appeal to the manufacturers of Toronto and the vicinity to meet the university in this regard, and I can assure them that in most cases whatever inconvenience they may be put to

by such an arrangement will be reciprocated in some form to the advantage of their work in connection with study and research which may arise from it. . . .

To summarize the curriculum it will be observed that there are three main divisions, all of which are common to the various courses and department of civil, mechanical, electrical, mining and chemical engineering, and architecture: (1) The sciences, mathematics, physics, chemistry and mechanics; (2) the graphic and mechanical arts, drawing, design and practical field or shop work; (3) the humanities, English, economics, languages, and possibly philosophy.

Value of the Broad Curriculum

It is not radical to make these and their subsidiary subjects common to all departments, for it is obvious that, for instance, the civil engineer must know something of electrical, steam, gas and other mechanical work; the electrical engineer of today must know something of hydraulics, masonry construction, railways, bridge building and even tunnelling, while the municipal and sanitary engineer must know considerable about electrical railways and pumps, steam engines and hydraulics in conjunction with the broad subjects of civics.

To pass further to these considerations and view them on a still broader horizon, the three main factors in the actual practice in which the graduate will engage may be resolved into scientific theory, the methods and practice in this application and the economic considerations. It has been said by some, with respect to the latter, that it is time enough when the graduate walks out into his professional life. Not so; if, when he is at the university, he has not been able to co-ordinate science and practice and obtain a sense of the economy of their application, he is going out into the world ill-fitted to take his place alongside the men who are already there; much less to attain to be a leader among them. More than this, the complex industrial conditions of today are understandable only by long, careful study by thinking men living in close contact with industry; how much better it is to give the student while at college his first acquaintance with these complexities and his basic principles of industrial management. The philosophy of values and costs, the psychology of labor and industrial problems and skill in expression in writing and speech are all subjects worthy of attention while the student is still at college. The practical academic process by which these can all be combined into one course of study in senior years seems reasonable when one considers how, for instance, a complete project from its inception may be followed through to its conclusion by a series of problems for class discussion, outside study in operating concerns, broad reading and an ultimate report of a comprehensive character.

In considering the problems of values and costs, of labor and industrial conditions and their relation to production which is now paramount in this country, it must be borne in mind that "the control of engineering lies in the hands of those who judge most accurately what enterprises men value sufficiently to be willing to assume the cost." Because engineering education has heretofore been confined mainly to technology, the engineer has seldom been placed on executive governmental commissions or other public boards—boards and commissions that must decide on how public funds shall be expended on enterprises that are essentially engineering in character. Why has it happened too frequently in the past that the engineer has been called in to do the technical work of design and construction only after a board comprised of lawyers, bankers, doctors, clergymen, merchants or politicians, has made a decision as to whether, from a standpoint of values and costs and other economic considerations the project under discussion shall in whole or in part go forward to construction? It is reassuring to know, however, that the idea is now developing that the public interest would be better served if the engineer had a greater voice in making such decisions.

Now to meet this new value which the public is beginning to place on the engineer, what are we going to do about his education? This is a distinct demand, if there ever was one, and the university should be the first to hasten to meet it. If the engineer and the applied scientist are to be prepared to take their proper places in the community they must be trained to appraise correctly what men consider to be worth while. . . .

As engineering and applied science expand into the new fields opening before them [quoting Dr. C. R. Mann] "the conception that character, judgment, efficiency, and understanding of men are no less necessary than technical knowledge and skill will become more and more impelling, and it will become more and more essential that engineering colleges pay greater attention to the effect of their work on the development of the students."

In discussing the papers on education at the annual meeting of the Engineering Institute of Canada, General Mitchell gave some additional figures regarding this year's registration at the University of Toronto. The total registration is 810, divided as follows: First year, 405; second year, 170; third year, 140; fourth year, 95. Electrical engineering leads in the number registered in the first year, 125; chemical engineering is second with 90, and civil engineering third with 70. General Mitchell expressed the view that the number registered in chemical engineering is an index of the change in point of view in the Dominion with regard to the future of its industries.

He also pointed out that the war had brought about in Canada a new liaison between industry and the colleges, and he hoped that that liaison would be strengthened. Already there is excellent co-operation between the colleges and the paper and pulp industry, while leaders in other industrial lines have indicated to General Mitchell their desire for close relations with the colleges. He suggested that the institute appoint a committee on co-operation between educational institutions and industry.

Proposed Salary Schedule for County Highway Engineers

DISCUSSION of the proposed salary schedule for county highway engineers, as prepared by the committee of the American Association of Engineers on salaries of engineers in public service, is requested in a recent circular issued by that committee. It is desired that the proposed schedule be submitted to the American Association of Engineers before winter closes, and the committee therefore requests that comments be in its hands prior to the middle of February. Communications should be addressed to A. N. Johnson, Chairman Committee on Salary of Engineers in Public Service, American Association of Engineers, 63 East Adams St., Chicago, Ill. Following is the proposed schedule:

ADMINISTRATIVE POSITIONS	
County Highway Engineer In charge of all county highway and bridge construction and maintenance.	$5,000-$12,000
Engineers of Construction Supervises all road construction and maintenance work, both contract and force account.	3,600- 6,000
Engineer of Bridges In charge of preparation of designs and specifications and construction of bridges.	3,600- 6,000
Office Engineer In charge of preparation of plans, specifications and estimates.	3,600- 6,000
SENIOR ENGINEERING POSITIONS	
Assistant Engineers Assigned to Office Engineer in preparation of plans and estimates computing and drafting, may act as chief draftsman.	$2,400- $4,000
Assistant Engineers In charge of tests and materials inspection.	2,400- 4,000
Assistant Engineers Assigned to Engineer of Construction or Engineer of Bridges acting as inspector of construction, also as chief of survey parties.	2,400- 3,000
JUNIOR ENGINEERING POSITIONS	
Draftsmen, Computers, Transitmen, Levelers	$1,800- $2,400
Rod and Chain Men, Tracers	1,200- 1,50

Asphalt Road Constructed on Macadam Base

State Prepares Old Macadam — Surfacing Performed by Contract — Selected Job Illustrates Construction

HOT haulage 15 miles by motor trucks from a stationary plant has been successfully employed in surfacing with asphalt a repaired bituminous-macadam road between Warnersville and Palmyra, Penn. This improvement is important as an example of the practice being resorted to by the Pennsylvania Highway Department to preserve the investment in macadam roads, of which the state has a large mileage. By successive coverings these roads have been built up to depths of 12 to 24 in., and in many instances have been reinforced with bituminous macadam. To preserve this original structure, when hard surfacing is undertaken, the old road is repaired by the department's maintenance forces, and is utilized as a base for the permanent surface, which is constructed by contract.

On the Warnersville-Palmyra road, 21 miles outside of the corporate limits of towns and villages along the route were planned for reconstruction. The specifications for the road call for a macadam base not less than 12 in. thick, with a tar application, covered by a sheet-asphalt surface 2½ in. thick, consisting of a 1½-in. binder course and a 1-in. top. No curbs are provided, but the edges are supported by 18-in. waterbound stone shoulders. The width of the surfacing is 18 feet.

Preparation of Macadam Base

State maintenance forces were utilized to prepare the old macadam base. This preparation consisted of lightly scarifying the old surface; scraping it with a road machine to remove the oil and dirt to the outside of the shoulder; adding sufficient stone to make the base 12 in. thick; reconsolidating, and binding with water. To determine how much extra stone must be added, test holes are dug at intervals to ascertain the thickness and condition of the base. From 4 to 5 in. of 3½-in. stone is usually required. As soon as the surface has dried out, traffic is admitted and allowed to use the road for a time to wear down and loosen up the surplus screenings. The base is then swept clean and covered with an application of tar product at the rate of 0.3 gal. per sq.yd. This is allowed to dry, but no covering material is placed upon the tar. The prepared base, with 2½- x 8-in. strips spiked down at the side to hold the surfacing during compression, is shown by Fig. 2. Traffic is excluded only while the asphalt surface is actually being laid.

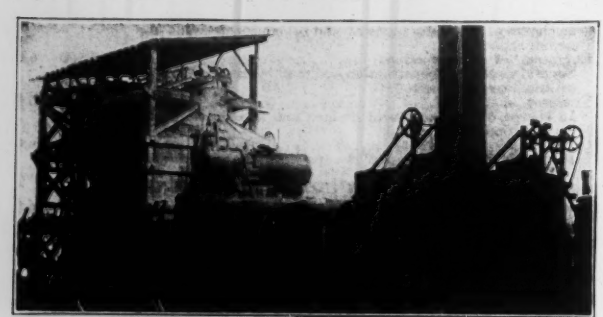


FIG. 1. ASPHALT PLANT AT CENTRALLY LOCATED STONE QUARRY

FIG. 2. SURFACING GANG PLACING ASPHALT DELIVERED BY MOTOR TRUCKS

The construction of the 21 miles of the sheet-asphalt surfacing is being conducted from one large, centrally located mixing plant. The maximum haul is somewhat over 15 miles. The plant is situated at a stone quarry, where the stone is crushed, dried, stored and mixed with the bituminous binder. No storage is provided for mixed material, which is immediately hauled onto the job.

A hard limestone is used for the binder, and is crushed upon the site. Sand is shipped in by rail and unloaded by a ⅝-yd. auto-crane. The sand and stone are dried by two 150-ton rotary dryers. Oil burners fed from four tanks with a total capacity of 13,500 gal. produce the necessary heat. The burners are placed at the outer end of the dryer cylinder, and the draft passes out through stacks at the inlet. The sand and stone are raised to a temperature of about 300° F. for mixing.

Prepared asphalt is delivered at the siding in tank cars, and is heated and unloaded into a large storage tank, where it is kept at a temperature of 300° F. by means of steam coils. The tanks are of concrete and have a capacity of 24,000 gal. When mixing is in progress the asphalt is pumped through a 5-in. main by a 15-hp. pump, and is kept heated in transit by means of a 1-in. heating line inside the 5-in. main. The specifications require a temperature of 300° F. at the mixer.

A general view of the drying and mixing plant is shown by Fig. 1. Two 80-ton storage bins are provided for heated sand and stone. The temperature of the stone and sand is maintained by the construction of the bins, which are of 3-in. plank and are lined with brick. A supply tank of heated asphalt, holding 5000 gal., is also situated at the mixing plant. Mixing is accomplished by a 15-cu.ft. mixer, giving a 1784-lb. batch of binder, and an 1830-lb. batch of topping. The specifications call for 4.7% of asphalt in the binder and 10½% in the topping.

Laying the Sheet-Asphalt Surface

Motor trucks haul the mixed material from the plant to its position in the road. These are three- to five-ton trucks of the ordinary dump box type. The material is protected in transit by heavy tarpaulins. Upon arrival at the road, the binder is spread to a depth that will compress to 1½ in., and this compression is secured by means of a 10-ton roller. After completion of the binder course, the topping is spread to a depth which will compress to 1 in., and initial compression is secured with a 10-ton roller. After initial compression, the

surface is rolled a second time with a five-ton roller. A closed binder is used for this work. The maximum day's work has been 3600 sq.yd. of binder and top in place; the average daily output is 3000 square yards.

After the completion of the 2½-in. surface, the planks along the edges are removed, and 18 in. of clean, crushed stone is placed on each side. After rolling with a 10-ton roller, this edge is covered with limestone screenings, wet down and puddled. Following this, the material, consisting of dirt, oil and stone, which was scraped off the surface after scarifying, is brought up against the stone edge to help complete the shoulder, which is finally finished with earth from the sides.

The contractor is the Union Paving Co., Philadelphia, Penn., and the contract price for the 2½-in. top was 91c. per sq.yd. J. F. Lourse is superintendent for the contractor. The work is done under the general supervision of the Pennsylvania State Highway Department, George H. Biles being deputy commissioner in charge of maintenance; W. D. Uhler is chief engineer of construction. Construction in Berks County is under W. R. Wolfinger, district engineer, and that in Lebanon County under C. W. Hardt, district engineer.

Tracklayer for Logging Railways

Machine Solves Labor Problem — Adapted to Handle Rails, Ties and Bridge Material on Ordinary Railways

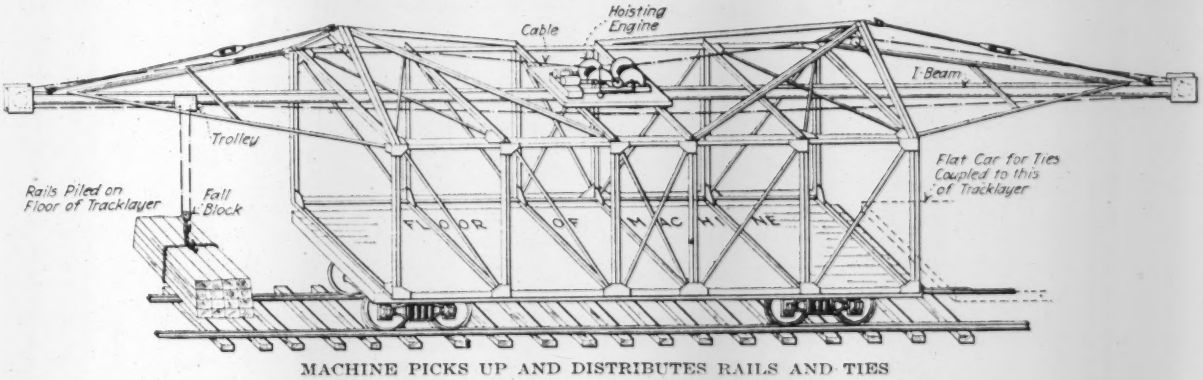
A TRACK-LAYING and track-shifting machine consisting of a car with cantilever runway for a hoisting trolley has been developed for labor-saving purposes on logging railways and is now in use on a number of lines of that class, while it is considered adaptable to ordinary railway service in such work as rail renewals and other maintenance work as well as bridge construction and repair. This machine, which is shown in the accompanying drawing, was designed by J. E. Norby, Portland, Ore., and described by him in a paper read before the Pacific Logging Congress.

In logging work it is necessary to lay, remove and relay many miles of spur tracks, the removal involving hard and dirty work in picking up the ties from a wet and muddy roadbed and carrying them to the work train. Mr. Norby used gangs of 26 men when possible, but it has become difficult to obtain sufficient labor and many men refuse to handle this heavy work. One method suggested was the use of a locomotive crane to pick up sections of track, but this did not appear practicable on account of the numerous curves, as the sections from one location would not fit on another location. An emergency condition arose when only four men were available at a time when about 12 miles of spur tracks had to be taken up and shifted. This led Mr. Norby to the design of the first machine, which has been improved upon in the later construction represented by the drawing.

Upon a large flat car is erected a steel frame 12 ft. high and 10½ ft. wide, with an I-beam attached to the upper members and extending 26 ft. beyond each end of the car, these extensions being supported by tie rods from the end frames and braced laterally by diagonal struts from these frames. On this beam travels a four-wheel trolley with pulley for the hoisting cable. At the middle of the car and mounted on top of the steel framing is a double-drum hoisting engine, supplied with steam from a locomotive, a flat car being placed between the locomotive and the tracklayer. The first tracklayer was used in combination with a steam logging machine, the drums of which operated the cables, but the present arrangement is simpler and more effective.

From one drum of the engine, placed as shown in the drawing, the cable is led to a pulley on the end of the trolley track and then back to the trolley, where it is passed over the latter's pulley and then around a fall block, from which it returns to an attachment on the trolley. From the other drum the cable leads to the pulley on the opposite end of the trolley track and then back to an attachment on the end of the trolley.

Rails and track fastenings are carried on the machine, while ties are carried on the flat car in the rear. In taking up a spur track, the spikes are pulled and two rail tongs connected by a cross chain are attached to a pair of rails. The fall block is hooked to this chain. By hauling in on the forward cable and holding the rear cable by the brake on its drum the fall block is hoisted and lifts the rails. They are then run back with the trolley by continuing to haul on the forward cable while releasing the out-haul cable so as to allow the trolley to travel on the I-beam. The rails are then lowered to the floor of the machine and the trolley is again run out by the back-haul cable. While these rails are being handled the ties are thrown together in a pile and wrapped with a chain, to which the fall block is hooked. The bunch of ties is then raised and run back through the machine and over the flat car in the rear, where the ties are dropped. The machine then backs away for one rail length and the operations are repeated.



MACHINE PICKS UP AND DISTRIBUTES RAILS AND TIES

In laying track the operations are reversed. A bunch of ties is picked up from the rear car and deposited

on the roadbed about half a rail length in advance so that no tie has to be carried more than about 15 ft. While the ties are being spaced, the trolley is run back and attached to the chain of the rail tongs, ready to carry forward a pair of rails as soon as the ties are in position. In rail renewals, the machine could pick up old rails and load them on the machine, and at the same time take new rails from a car in the rear and drop them in the track. Or it could distribute new rails outside of the track and pick up the old rails from the same position. Bridge timbers, girders, frogs and switches and other materials can be distributed and picked up the same way.

With this machine track can be lifted or laid by four men, in addition to the engine crew, but 10 to 12 men form the usual gang. In regular work, 12 men with a foreman, the machine and an engine crew have averaged 1800 ft. per day, either lifting or laying, while Mr. Norby estimates that with 26 men an advance of about a mile a day can be made. As the heavy and dirty manual labor is eliminated there is little trouble now in getting men for the work. With hand labor at war prices the labor cost was about $400 per mile, but with the machine this has been reduced to about $190, doing more work with fewer men. This machine is built by the Norby & Fox Co., Portland, Ore.

Simplicity of Classification in City Zoning Ordinances

Excerpt from a paper on "Residential and Industrial Zoning," delivered in December, 1919, by Herbert S. Swan, New York City, before the Citizens' Zoning Conference at Chicago.

THE simplicity or complexity of its classification will affect as no other factor the continued success of a plan, for, after all, zoning is almost entirely a matter of classification. If the classification is vague, ambiguous or needlessly involved, it is apt to prejudice the operation of the whole plan.

These facts do not seem to be generally appreciated. Some cities appear to think that the prime requisite in a good zoning scheme is elasticity. A certain amount of elasticity is, of course, wanted, but not at the expense of simplicity. The Minneapolis and Berkeley ordinances are both illustrations of instances where extreme consideration has been paid to elasticity. The Minneapolis ordinance subdivides trades and industries into 16 different classes; the Berkeley ordinance into 20 different classes. Taken in all their possible combinations, the building classes of the Minneapolis ordinance would permit 241 separate and distinct kinds of industrial use districts. The Berkeley ordinance would permit of 381 separate and distinct kinds of use districts. Such elasticity is bound to develop into a situation where ultimately each district will be just a little different from every other district, with the consequence that nobody will know what is allowed or disallowed in any district.

It may be urged that it is very unlikely that all of these combinations will ever be taken advantage of. This may be true, but their very possibility will lead to the development of unnecessary complications. That such minute refinements in the classification are bound to prove irksome, if not unworkable in practice, is evidenced by the fact that Berkeley, after less than two years' experience under its zoning ordinance, is contemplating its radical amendment by reducing the classes of industrial use districts to a maximum of five.

The classification is the substance of every district, the district merely bounds the classification. Once accepted, therefore, classification must be continued, as any vital modification in its provisions would practically necessitate a general rearrangement.

Classes of Use Districts

Although a zoning ordinance should have a simple classification, it should not sacrifice needed protection for simplicity. This seems to be the main characteristic of the Alameda and Los Angeles ordinances. These ordinances provide only two classes of districts. In the residence districts the businesses not especially excluded are permitted; in the industrial districts all kinds of business and industry are unrestrained. Neither of these ordinances protects residence streets from stores, nor business streets from large factories or nuisance uses.

The New York ordinance, in establishing these classes of districts, supplies both of these omissions. The residence districts exclude all kinds of business and industry; the business districts all kinds of large manufacturing establishments and nuisances. But the New York classification is weak in one respect, it does not afford sufficient protection to manufacturing. If a factory requires more than 25 per cent of the floor area in a building, or a floor area in excess of the lot area, whichever is the greater, it is forced into the unrestricted district containing all kinds of nuisances.

To put manufacturing establishments and nuisance uses into the same classification thus is apt to produce many unhappy compromises, as every unrestricted district will be the result more or less of a balance struck, on the one hand, between the just claims of the district for factory development, and, on the other hand, the protection demanded by neighboring residence and business districts against nuisances. In some cases nuisances will be allowed where they will do great harm, for no better reason than that the locality is naturally a manufacturing district; in other cases, factories will be prohibited on the ground not that their admission is undesirable, but because the nuisances that might slip into the district with them would prove a serious menace to adjoining districts. The Newark and St. Louis ordinances in creating four classes of districts—residence, business, manufacturing and nuisance—are in this respect a distinct improvement over the New York ordinance.

Exclusion of Residences

A special feature of the Newark ordinance is the exclusion of residences from the heavy industrial district. This plan has many distinct merits. The very reasons that make it desirable to exclude factories and nuisances from residence districts apply with equal, if not greater, force when it comes to prohibiting the erection of new dwellings in districts set aside for industrial devolpment. If it is unhealthful for people to live near a factory isolated in the residence district, it is all the more unhealthful for them to live in a home isolated in the industrial district. To permit residence buildings in factory districts, moreover, tends to increase the size of these districts beyond their natural requirements, as the area included in this classification must also make provision for the erection of a considerable number of dwellings.

Report on Development of Unused Lands

A Study of the Possibilities of Reclaiming Arid, Wet and Cut-Over Timber Lands, Made by U. S. Reclamation Service in the Latter Part of 1919

NUMEROUS projects for land reclamation, together with much interesting and suggestive general discussion of the subject as a whole, are presented in the "Report on the Development of the Unused Lands of the Country," made by the United States Reclamation Service in the latter part of 1919 and printed for the use of the Committee on Irrigation of Arid Lands, House of Representatives. The investigation was made under authority of a Congressional appropriation item of $100,000 which authorized the director of the Reclamation Service to make a study "of the reclamation by drainage of lands outside existing reclamation projects and of the reclamation and preparation for cultivation of cut-over timber lands in any of the states of the United States." The work was under the general charge of Arthur P. Davis, chief engineer and director U. S. Reclamation Service, and in direct charge of F. W. Hanna, H. T. Cory, and F. E. Weymouth.

The country was divided into three districts, with Mr. Hanna in charge of the Eastern States north of the Ohio River and of cut-over lands in the Northwest; Mr. Cory in charge of Southern States; while Mr. Weymouth conducted investigations of irrigation and drainage in the Western States. The report falls in three parts: The first being for the most part general and of unstated authorship, and the other two being by Mr. Cory and Mr. Hanna for the Southern and the Northwestern States, respectively. Part I contains specific suggestions for further irrigation development in the Western States.

Opportunity for Returned Soldiers and Sailors

Secretary Lane, in a letter transmitting the report, says of the investigation: "This work has been carried on in the prospect that Congress would see fit to give to our returned soldiers and sailors an opportunity to go upon these lands under proper guidance and convert them into home farms for themselves." It may be noted, however, that the general discussion as well as the various conclusions presented as to different projects are applicable to any scheme of land reclamation and settlement that recognizes the necessity for Federal or state aid and for some general community plan of development.

Writing of the financial feasibility of a large Federal land settlement scheme, Secretary Lane says in his letter of transmittal: "If the objection is raised that the Federal finances will not support the drain proposed, I beg to advise that I am authoritatively informed that there will be no difficulty in selling $500,000,000 in Government 3¾ per cent non-taxable bonds which would be sufficient to cover the expenditures contemplated under the Smoot-Mondell bill. This would be in the nature of a reimbursable fund, the whole being repaid over a long period by the farm owners."

Reservoir Sites Should Be Saved

That by no means all of the unused lands in various parts of the country are properly subject to reclamation for agricultural purposes is pointed out in Part I of the report. Some of the swamp and overflow lands would be far more useful as reservoir sites, for flood control, for river regulation or other purposes than agriculture. In like manner some of the cut-over areas might be of far more ultimate value to the country if the timber upon them were allowed to mature before these lands were cleared for agricultural purposes, and in some instances it might well be that these areas should be retained permanently for forest purposes. Some of the abandoned farms in New England, the report points out, are so hilly and rocky that they should never have been cleared. Two sentences may be quoted as summarizing this section of Part I: "By a wise and skillful discrimination we must select those areas requiring the least expenditure and least destruction to reduce them to cultivation, and must leave uninjured and adequately protected the areas needed for water storage and those most suitable for forest production. This still leaves an ample choice in the states mentioned for all of the reclamation that is likely to be carried out within the next generation, although the rules upon which selection is made must obviously be modified from time to time." (The words "states mentioned" refer to the Lake, Southern Atlantic and Gulf States.)

Reclamation by Fertilization and Correction of Acidity

Some of the states presenting little opportunity for the reclamation of either arid, wet or cut-over lands nevertheless afford chances for profitable reclamation, such as lands needing fertilization or else the correction of acidity by the addition of lime or by the use of other antidotes. There are certain areas that have deteriorated through occupancy and use by tenants rather than owners. "Where such areas can be acquired and cut up into homes," the report states, "they may be restored by proper tillage methods and the addition of nitrogen or other plant food until they are capable of constituting thickly settled and prosperous colonies."

Examples of land deterioration through tenantry are found in some of the Mississippi Valley states. Cut-over lands adaptable to agriculture are available in considerable areas in New York and Pennsylvania, these areas being in proximity to good markets and having good transportation facilities. There are also lands in New York needing drainage that would apparently "afford favorable locations for colonies."

The New England Problem

As an "extreme case of local need for agriculture," New England is cited in Part I. Agricultural production in that section is "but a fraction of what it was a quarter century ago, while the growth of population and of manufacturing industries makes a market which draws more and more for subsistence upon the Mississippi Valley and the Far West."

In general terms the decline of New England's agriculture has been due to "the demand of its growing manufactures for the necessary labor and the competition of cheap, fertile and extensive agricultural areas of the Mississippi Valley and the great West. These lands," the report continues, "are no longer cheap, and the growth of the Middle West is to a large extent absorbing the production of the Western farms so that New England must enter into active competition for

its food supply under the handicap of costly transportation. This condition has reversed the influence which led to the decline of New England agriculture, and in providing for its rehabilitation the soldier settlement program affords the opportunity of doing this, and at the same time keeping at home the thousands of soldiers who enlisted from these centers of population." Taking up next the Southern division of the country, the report says that the largest areas open to colonization are cut-over lands. The merchantable timber has been removed from these lands by large companies, many of which are now anxious to sell the stripped land at low prices. In some cases drainage would be required, or improvements in existing drainage made. A few important sentences from this section of the report may be quoted:

Elimination of Mosquitoes Necessary

"In some of the richest localities where land can be had very cheaply, one of the principal drawbacks which must be overcome is the elimination of the swarms of mosquitoes, which will require careful surface drainage and elimination of stagnant water. Also the clearing of luxuriant vegetation which springs up after the timber is removed. Such areas can only be successfully colonized in tracts of considerable size as it is impracticable to carry out mosquito extermination on a small scale. In many of the Southern States, especially the border States, are to be found extensive areas which have been neglected since the Civil War and are of similar character to those described in New England. They can generally be purchased cheaply and rendered fertile by clearing and the addition of lime and nitrates."

As to the Western States, the report points out that the Dakotas, Nebraska, Kansas, Oklahoma and Texas "have considerable areas of humid lands in which drainage is frequently needed and irrigation is not needed. . . . Drainage can, in many cases, be provided at reasonable cost, and where clearing is necessary this is comparatively inexpensive. Farther west irrigation projects have been investigated in the past and numerous opportunities of feasible development of this character exist in most of the Western States." West of the 100th meridian there are many opportunities for reclamation by irrigation, by drainage, and the clearing of cut-over lands, chiefly in Montana, Idaho, Washington, Oregon and California. East of the mountain ranges the necessity for irrigation as well as clearing and leveling lands "is usually prohibitive even in the cases where irrigation is feasible at all, and in such cases it is usually best to encourage the reforestation of the lands by protecting the young growth from fire." On the Northern Pacific slope "are large areas of cut-over lands, where deep and excellent soil occurs, where the topography is suitable and where the rainfall is also sufficient for successful farming. Some areas in this region can be profitably and wisely devoted to agriculture, but in a large portion the cost of clearing, owing to the number, size and character of the stumps that are in the way, would, at present values of agricultural land, make the enterprise prohibitive, and the land can best be utilized by reforestation. This is true also, to some extent, in western Oregon and northwestern California. A large portion of the cut-over lands in the Northwest is, of course, unsuitable for agriculture on account of topography and rocky soil and can best be restored to forest condition."

Of the area of arid land west of the 100th meridian which is not too high, cold or rocky for agriculture "over 15,000,000 acres have already been placed under irrigation by private or public enterprise, and in carrying out this work of course the more favorable opportunities for such irrigation have been developed. It will still be possible to add many million acres to the irrigated area and perhaps to double the area now irrigated, but this must generally be done at high cost, as the cheap opportunities have long since been exhausted. There are remaining, however, many areas which can be irrigated within feasible costs and will develop values far in excess of necessary expenditures. They will furnish healthful homes for settlers and will supply agricultural products and food resources in proximity to great mining and grazing resources which will be made more valuable thereby. There is much room for wise and profitable activity in this line in most of the Western States, but the total areas that can be thus reclaimed are much less than those offering opportunities in the states farther east."

At this point seventeen pages of the report are devoted to outlining possible irrigation projects in nearly as many of the Western States.

Large-Scale Operations Would Be Required in South

In the Southern district, comprising Texas, Oklahoma, Arkansas, Kentucky, West Virginia, Maryland and Delaware, and all states to the south and east of those, sixteen in all, Mr. Cory states that most of the unused lands could be developed "only with enormous expenditure, or great length of time, or both." But there is much land in the Southern district that "can be completely cured for surprisingly low cost and in very short spaces of time *if done by operations on a very large scale.* [Italics ours.—Editor.] Two checks on productivity of land in the Southern division are mentioned by Mr. Cory as being depletion of fertility, which "can be restored at quite reasonable cost and in a relatively few years," and "locality 'backwardness.'" Mr. Cory continues:

> The ambitious have steadily gone out to more promising fields of human activity with the result that little and often negative progress has been made in local community life, while throughout the nation as a whole, in rural as well as industrial communities, advances in civilization have been very great.
>
> Thus it is that while "abandoned land" can be brought back often to high fertility much cheaper than raw lands in new sections can be subdued, or in progressive sections purchased, nevertheless its desirability and hence its sale price when renovated is often less than the necessary expenditures upon it. In other words, a fertile, revamped farm in the midst of a large area of abandoned land would have so much less real value than were it in the midst of a progressive region. Only part of the trouble can be removed by any individual. [Restoration of] the low fertility . . . . . will normally take a long time according to American standards.

A Clean Slate and a New Start Needed

> To do the job completely it is necessary to treat relatively large compact tracts as a whole, *and not only renovate the soil but also wipe off the existing developments to such an extent as to quite obliterate social institutions, folkways, standard of living, and habits of thought, and establish in place thereof modern communities.* [Italics ours.—Editor.] This, however, requires large amounts of money under one control—in other words, operations on a large scale.
>
> Similarly, the real value of a thoroughly up-to-date, completely developed farm in the midst of a great tract of cut-over land is quite low. The few inhabitants almost invariably have low standards of living and social interests, and the time normally required for the region as a whole

to develop is too long to make the investment of money and nervous energy in producing a good farm attractive to the ambitious man. *But if really large tracts are taken and entire communities treated in one operation the total costs will be very well worth while—again a matter of operation upon a scale far beyond the reach of individuals, even though assembled together in co-operative organizations of a practicable size.* [Italics ours.—EDITOR.]

. . . . . .

In short, the way most economical, both in money and human struggling and tragedy, and often the only feasible way, to get into use or reclaim "unused lands" is by *large-scale operations and planned rural communities.* [Italics ours.—EDITOR.] The investigations which are the subject of this report disclosed the fact that there are enormous acreages of these lands, which can be profitably reclaimed and which would then be admirably adapted for agricultural purposes.

WESTWARD—NORTHWARD—SOUTHWARD

In an illuminating but very concise discussion of "Land Settlement in the South" Mr. Cory says:

Whatever might have been the case 25 years ago, the conditions in the Southern district are now as favorable, all things considered, as in the North and West, provided—and only provided—the community settlements are of considerable size.

The movement westward has resulted in making agricultural land values really higher in the Western States, everything considered, than elsewhere in the country. Then it turned north, and 1,600,000 Americans have gone over into Canada during the great settlement movement of the Canadian Northwest, begun a few years before the World War. There are a few sporadic instances indicating that the beginnings of a trend back and to the South are in evidence. Doubtless these will steadily but slowly increase. The plain facts are that something spectacular is necessary to break up the existing psychology, not only of the American people but of foreign immigrants to America, as to the relative opportunities in the South and in the West for securing agricultural homes.

After careful examination of many data and numerous conferences with leading Southern public-spirited men, the only thing, that is at the same time practical and probably successful, to be thus far suggested, is for the United States Government as such to place its stamp of approval upon numerous sections throughout the South. Of course, this has in effect been done, in that one department has approved of its soil conditions; another department has investigated and published many data concerning its biological features; and a third has been giving publicity to crop adaptations, etc., but all of these facts go out independently and piecemeal—one might say, ooze out—and attract little attention.

. . . . . .

Summarizing, then, the success of soldier settlements upon the unused or partially used Southern lands should be great, due to: (1) Completeness of project as a planned rural community; (2) the relative advance in planned rural development over the existing local standards; (3) the far-reaching effect upon the whole southeastern part of the United States by numerous demonstrations of the country's natural resources as distinct from its agricultural development up to this time.

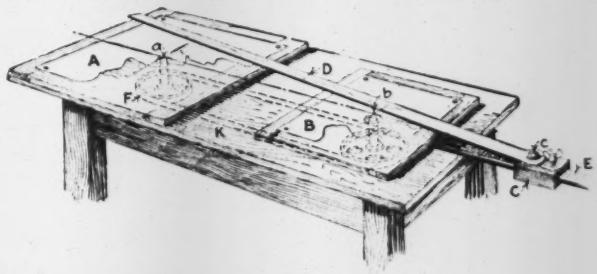
Mr. Cory then passes in review conditions and opportunities in the various Southern States.

In Mr. Hanna's report on the Northern division—which it should be remembered includes the consideration of land needing drainage and cut-over lands in all the New England, most of the North Atlantic, all of the North Central States besides Kansas, Nebraska, North and South Dakota, and in addition cut-over lands in California, Idaho, Montana, Oregon and Washington—he reviews broadly the swamp lands, lands subject to overflow and the cut-over timber lands and the adaptability of the various areas to cultivation and the means of reclamation that seem feasible. Cut-over lands alone, so far as disclosed by the investigation, are estimated to total an area of 22,483,000 acres, including 3,645,000 acres in the five far Western States already mentioned. This total does not include lands suitable for grazing. The portion apparently available for community settlement, and given consideration in the report, reaches 10,237,000 acres. The total estimated occupied area of cut-over lands in Mr. Hanna's section of the country is estimated at 74,605,000 acres. As to swamp and overflow lands in Mr. Hanna's division the total estimated present acreage is 22,866,000, of which 4,259,000 were investigated, and of this latter it is estimated that 1,176,000 acres are available for settlement. Somewhat similar figures for each of the states investigated are given by Mr. Hanna, together with many other data.

Drawings Reduced or Enlarged by Straight-Edge and Revolving Boards

BY GEORGE H. GILCHRIST
Ottawa, Can.

TWO rotating drafting boards A and B are carried on a fixed platform (table) K and rotate about their centers a and b in a horizontal plane. Each drafting board is attached to a large pulley. The pulley and drafting boards rotate together equally on the same shaft, being so connected. The two pulleys F and G are of equal diameter and are connected by a belt or any mechanism to give the same effect. Thus the two



DESIGN OF DRAFTING BOARDS BASED UPON FUNCTIONS OF SIMILAR TRIANGLES

boards A and B rotate equally, always having the same orientation with respect to each other.

A movable block is adjustable along a track E and is held in position by a thumbscrew. A straight-edge D is pivoted on block C at point c and is free to move over surface of drafting boards about the point c.

Points a, b and c are in one straight line. To transfer a straight line on A to drafting board B, move the straight-edge and rotate the boards A and B until the edge of the straight-edge D is superimposed on line to be transferred. Then draw a line along the edge of the straight-edge on B.

The ends of the line may be transferred as a point is transferred. A point is transferred by transferring any two lines passing through that point. A circle is transferred by using its center and any point on the circumference and then employing a compass. An arc of a circle requires three points, its center and the ends of the arc. A curve is reproduced by means of sufficient points to sketch the curve in by joining up the points.

Relation between the two scales of the drawing is governed as follows:

$$\frac{\text{Scale of drawing on } A}{\text{Scale of drawing on } B} = \frac{ac}{bc}$$

An enlargement in scale is, of course, obtained by placing original on board B. No scales are required. A set square is required for hatching, etc.

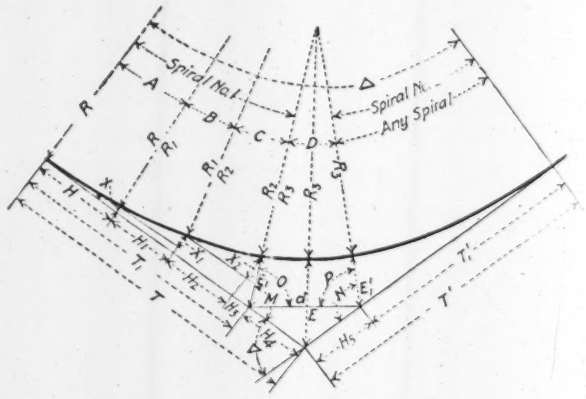
Simple Solutions of Compound Curve Problems

Time Saved New York State Railways Engineering Corps by Use of Short Methods in Its Instruction Book

SOLUTIONS of many problems met in laying out compound curves for track work have been simplified and standardized for the engineering staff of the New York State Railways, in a book of instructions prepared by L. R. Brown, office and field engineer of that company. Four of them are presented here.

A knowledge of trigonometry, of course, provides the means of solving any of the problems which occur in such work, but some of the possible solutions of each are so lengthy and involved that too much time is usually spent in working them out. That the use of the simple methods given in his systematic arrangement of instructions has been a big time-saver was stated by Mr. Brown in an article in the *Electric Railway Journal* briefly describing the accompanying illustrations from his book.

The first solution shown (upper right) is for finding the tangents and external of any compound curve when the radii and angles are given. In appearance this method seems rather long and somewhat laborious, but in the arrangement of the various formulas particular attention has been paid to the selection and arrangement of the equations so that they may be easily solved by logarithms. This solution gives co-ordinates for staking out the curves, and can be used with any combination of standard spiral when the total angle and the distances T and E of the spirals are known.



METHOD OF FINDING TANGENTS AND EXTERNAL WITH RADII AND ANGLES OF ANY COMPOUND CURVE GIVEN

$X = R \text{ vers } A$, or $= 2R \sin^2 \frac{A}{2}$, or

$= R \tan \frac{A}{2} \sin A$

$H = R \sin A$

$X_1 = 2R_1 \sin \frac{B}{2} \sin \left(A + \frac{B}{2}\right)$

$H_1 = 2R_1 \sin \frac{B}{2} \cos \left(A + \frac{B}{2}\right)$

$X_2 = 2R_2 \sin \frac{C}{2} \sin \left(A + B + \frac{C}{2}\right)$

$H_2 = 2R_2 \sin \frac{C}{2} \cos \left(A + B + \frac{C}{2}\right)$

$E_1 = (X + X_1 + X_2) \div \cos (A + B + C)$

$H_3 = (X + X_1 + X_2) \tan (A + B + C)$

$T_1 = H + H_1 + H_2 + H_3$

Then use same solution for Spiral No. 2

$\frac{1}{2}(O + I) = 90° - \frac{1}{2}D$

$\text{Tan } \frac{1}{2}(P - O) = \frac{(R_3 + I'_1) - (R_3 + E'_1)}{(R_3 + I'_1) + (R_3 + E'_1)} \tan \frac{1}{2}(P + O)$

$P = \frac{1}{2}(P + O) + \frac{1}{2}(P - O)$

$O = \frac{1}{2}(P + O) - \frac{1}{2}(P - O)$

$d = \frac{(R_3 + E_1) \sin D}{\sin P}$

$N = 90° + \text{angle of Spiral No. 2}$

$M = 90° + A + B + C$

$H_4 = \frac{d \sin (N - P)}{\sin \Delta}$

$H_5 = \frac{d \sin (M - O)}{\sin \Delta}$

$R_3 + E = \sqrt{(R_3 + E_1)^2 + H_4^2 - 2(R_3 + E_1) H_4 \cos M}$ *

$T = T_1 + H_5$

$T' = T'_1 + H_5$

$E = (R_3 + E) - R_3$

If Spiral No. 1 is the same as Spiral No. 2

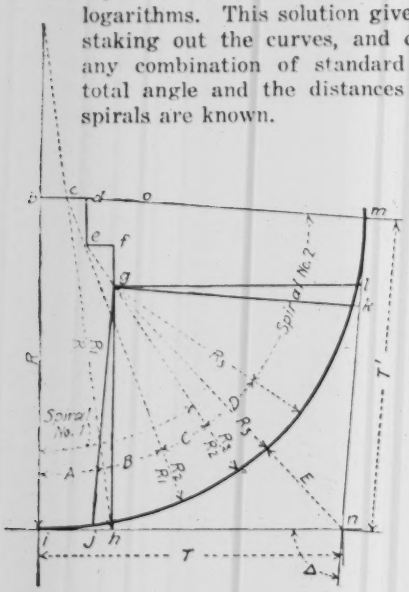
Then

$H_4 = \frac{\sin \frac{D}{2} (R_3 + E_1)}{\cos \left(A + B + C + \frac{D}{2}\right)}$

$R_3 + E = \frac{\cos (A + B + C)(R_3 + E_1)}{\cos \left(A + B + C + \frac{D}{2}\right)}$

And $H_4 = H_5$

*Note that this is a continuation of the expression under the radical sign above.



Given radii and angles of any compound curve. Find tangents and external.

Draw bc, cl, ef and gl parallel to T, de, fg and gh parallel to R, gj parallel to T_1 and gk parallel to mo

$bc = (R - R_1) \sin A$, $cd = (R_1 - R_2) \sin (A + B)$, $ef = (R_2 - R_3) \sin (A + B + C)$

$ab = (R - R_1) \cos A$, $de = (R_1 - R_2) \cos (A + B)$, $fg = (R_2 - R_3) \cos (A + B + C)$

$gh = R - (ab + de + fg)$, $ih = bd + ef$

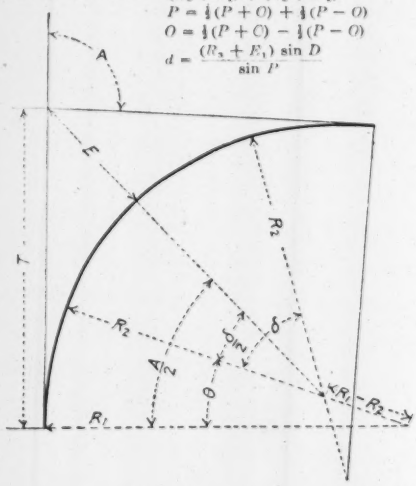
$jh = gh \tan (90° - \Delta)$

Similarly from Spiral No. 2 find gk and kl

$T = gl + ih - jh$

$T' = jg + km - kl$

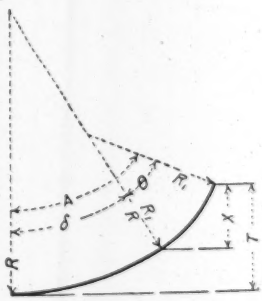
$E = l \sqrt{gh^2 + hn^2} - R_3$



Given R_1, R_2, A, δ and θ. Find tangent and external

$$T = R_1 \tan \frac{A}{2} - \frac{\sin \frac{\delta}{2} (R_1 - R_2)}{\cos \frac{A}{2}} \quad (1)$$

$$E = \left(\frac{T - (R_1 - R_2) \sin \theta}{\sin \frac{A}{2}}\right) - R_2 \quad (2)$$



Given R, R_1, δ, X. Find θ

$\text{Cos } (\delta + \theta) = \cos \delta - \frac{X}{R_1}$

$\theta = (\delta + \theta) - \delta \quad (1)$

Given T, R, R_1 and A, find δ and θ

$A = \delta + \theta$

$\text{Sin } \frac{\delta}{2} = \sqrt{\frac{T - 2R_1 \sin^2 \frac{A}{2}}{2R - 2R_1}}$

$A - \delta = \theta \quad (2)$

Given T, R, A, δ and θ, find R_1

$$R_1 = \frac{T - 2R \sin^2 \frac{\delta}{2}}{2 \sin^2 \frac{A}{2} - 2 \sin^2 \frac{\delta}{2}} \quad (3)$$

SOLUTION OF SEVERAL COMPOUND CURVE PROBLEMS. LEFT—FIND TANGENTS AND EXTERNAL OF ANY COMPOUND CURVE WITH RADII AND ANGLES GIVEN. CENTER—GIVEN R_1 R_2 A, δ AND θ. FIND TANGENT AND EXTERNAL. RIGHT—GIVEN R, R_1, δ X. FIND θ.

A much easier and quicker method of computing the tangent distances and external of a compound curve made up of several radii is shown in the illustration on the lower left. On the lower center is shown a more simplified solution of a symmetrical compound curve of three radii. The solution of another problem that frequently occurs in track work is shown on the lower right. This problem arises when the devil strip is changed at a branch-off, or when a switch and mate are changed for a pair of another radius.

In his article Mr. Brown offered to furnish trigonometric derivations of the various formulas shown to anyone who desired them.

County Highway Surfaced With City Pavements

By James Logan
County Engineer of Burlington County, N. J.

THOUGH city pavements have never been extensively used in rural communities, even where the traffic would warrant them, some types can be advantageously utilized in certain localities on county highways. The type of pavement selected must not only meet the traffic conditions but must be of reasonable first cost and low maintenance cost. Burlington County, N. J., during the year 1916 constructed, upon a well-graded gravel road, a macadam road 18 ft. wide with a foundation 6 in. thick after being compacted. Upon this base in 1917 was placed a sheet asphalt surface composed of a 1-in. binder course and a 1½-in. topping. This road, extending from Mt. Holly northeasterly three miles toward Trenton, is now in use.

As Burlington County is the leading agricultural county in New Jersey and geographically situated so that its products may be carted by motor truck to the markets of New York and Philadelphia, it requires roadways that will support at all seasons of the year all types of traffic. The traffic on the above-mentioned road is very heavy during certain seasons of the year, as it leads from the center of the farming district to Trenton and New York, and it also has been used extensively by Government trucks going from Philadelphia to Camp Dix.

In building this highway the foundation of macadam was thrown open to the public as soon as it was completed. For a year prior to the surfacing extensive traffic moved over the road. During the surfacing, as soon as sections of the road were completed, they were thrown open to traffic. The road is two years old now and has had continuous heavy travel since construction. It has been subjected to the extremes of temperature—10 deg. below zero being recorded during one of these winters, and the following summer the thermometer registering a maximum of 106 deg. F., and during the hottest day 140 trucks, heavily laden and in one train passed over the road. No patching or maintenance of any kind has been necessary to date.

Practically all of the materials that went into the road were either of local origin or were obtained with short railroad haul. The county produces a good quality of sand useful for bituminous mixtures and not only has a sufficient supply for local uses, but ships a good deal to centers of population along the Atlantic seaboard for use in bituminous work. A good bank of sand is to be found at Mt. Holly, the western terminus of the road, and trap-rock of superior quality was obtained by a railroad haul of 34 mi.

As the soil in this county is a sandy loam, and in most places the top soil being underlaid with a stratum of sand, excellent natural drainage obviated extensive work in this connection. The road in question, having been previously improved with gravel, was satisfactory as to longitudinal and transverse grade, and the drainage could not be improved upon. The foundation was constructed of broken stone, the first course being spread upon the gravel subgrade after it was rolled and shaped. The bottom layer of stone was 2½ in. in size and the voids were filled with a road gravel containing a large percentage of clay. This was thoroughly compacted by rolling with a 10-ton roller. Upon this was placed the top course of 1½-in. broken stone which was bound together with some gravel and finished off with screenings. After the foundation had been subjected to heavy travel for a period of a year the sheet asphalt paving was laid. When the top was applied the foundation had worn to the 1½-in. stone with every stone showing. Specifications for the sheet asphalt surface required the following grading:

	Asphalt Cement	Surface Mixture	Binder
Penetration of A. C.	54		
Ductility	100 cms.		
	Per Cent		
Fixed carbon	17 9	....	
Mineral matter	0 05		
Organic insoluble	0 05	Per Cent	Per Cent
Bitumen	99 90	11 0	4 7
Passing 200 mesh	.....	13 0	1 2
Passing 100 mesh	.....	17 0	
Passing 80 mesh	.....	10 0	5 4
Passing 50 mesh	.....	13 0	
Passing 40 mesh	.....	11 0	
Passing 30 mesh	.....	4 0	8 0
Passing 20 mesh	.....	8 0	
Passing 10 mesh	.....	12 0	4 2
Passing 4 mesh	.....	1 0	3 4
Passing 2 mesh	.....	....	11 3
Passing ½ in. mesh	.....	....	19 8
Passing 1 in. mesh	.....	....	27 8
Passing 1½ in. mesh	.....	....	14 2

The asphalt plant was located in the freight yard at Mt. Holly within 150 ft. of the sand dunes. Mt. Holly is four miles from the northeast terminus. The gravel pit was located along the road at its middle. The gravel cost 10c. per cubic yard in the pit. Materials were mixed at the plant in Mt. Holly and hauled in 5-ton trucks to the road. All materials were subjected to rigid tests. A chemist was stationed at the plant who inspected the mixing of the materials and an inspector was on the road supervising the placing and compressing of the mixtures. Labor at that time was receiving $3 per day of nine hours. The foundation cost $1 per square yard completed. The surface cost $1.32 per square yard, which included a gravel shoulder 6 ft. wide, compacted 2½ in. thick on each side.

During 1918 3 mi. of sheet asphalt were laid on 6 in. of concrete on the main road to Philadelphia which is called upon to support heavy travel. During 1919 20 mi. were contracted for and about 15 mi. have been completed. The county has a program for three years of 20 mi. a year. Together with modern pavements previously constructed, this county will have in 1922 a road system, composed principally of sheet asphalt, of 90 miles.

Alaska Free From Unrest

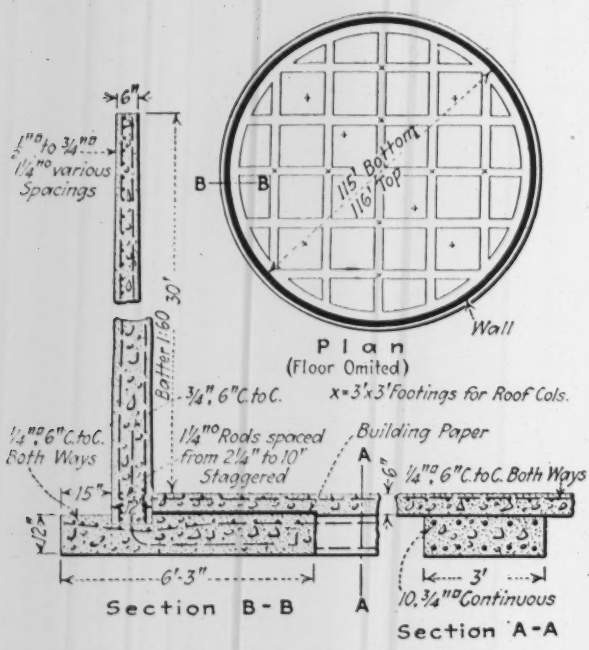
A recent letter from Juneau, Alaska, to a New York business man, contains the information that Alaskans are not troubled with conditions of unrest and that Bolshevism is not to be found there.

Large Concrete Oil Tank Built For Panama Canal

Shortage of Steel Led to New Use of Concrete for Isthmian Oil Storage—Tank Is 115 Ft. in Diameter and 30 Ft. Deep

By R. C. Hardman
Engineer-Designer the Building Division, Panama Canal

STEEL shortage during the war, together with the existence of a large supply of 1¼-in. round bars which were purchased for another project and not used, determined the use of reinforced concrete for a 55,000 bbl. fuel-oil tank constructed in 1918 at the Mount Hope Oil Tank Farm, near the Atlantic terminus of the Panama Canal. As this farm contained a number of steel tanks of similar capacity, the same general dimensions were used for the concrete tank; i.e., 115 ft. in diameter and 30 ft. in height.



DETAILS OF CONCRETE FUEL-OIL TANK FOR PANAMA CANAL

The tank is located on a hill about 30 ft. above the surrounding country and rests upon a foundation of red clay. As a measure of protection against varying soil conditions the foundation consisted of a gridiron of ribs, as shown in the drawing, reinforced top and bottom, to enable them to take care of any uneven settlement at soft spots and prevent cracking of the floor slab. The tank walls being circumferential, the design was very simple. As the temperature changes on the Isthmus are small, no provision was made for temperature stresses. Elongation due to stress is provided for by sliding; it will be noted in the drawing that the wall is secured to the footing under it, the whole being independent of the floor slab and ribs. By this construction changes due to elongation can take place readily. Building paper was used between the floor slab and the wall footing. No special means of securing a tight joint between wall and wall footing were used. In two fuel-oil tanks designed by the writer for the Panama Gas Co. and the Colon Gas Co. a thin metal strip was imbedded in the footing and the walls built over it.

Footings for roof columns, 17 in number and 3 x 3 ft. in size, were provided at the center of the tank and at the third points of the radius with 45 deg. separation. The original design called for a wooden roof with tar and gravel covering, but was later changed to the ordinary steel-plate construction, as is customary on steel tanks, and is required of privately owned oil tanks on the Isthmus.

The tank is provided with an 8 in. swing-joint supply and discharge pipe, 30 ft. in length, so placed to draw off oil at any depth, and operated by means of a hand winch on the roof. The pipe enters the tank through a cast-iron sleeve with circumferential ribs on the inside for lead calking. Two cast-iron clean-out holes with blind flange covers are provided near the bottom of the tank, as well as a 3-in. drain for drawing off water which collects at the bottom of the oil. Entrance to the tank is by inside and outside ladders built into the wall, and a manhole in the roof.

Steel stresses of 16,000 lb. per sq.in. were used. Unit weight of oil was taken at 54 lb. cu.ft.

Forms for the tank were made in sections about 6 ft. in height and 10 ft. in length, bolted together circumferentially, the inside and outside forms being likewise held together by bolts. Lifts of 6 ft. of wall were poured, and the forms removed, raised and placed for the next lift, thin strips being placed between inside form sections at each operation to take care of the increased circumference due to batter.

Immediately upon removal of the forms all suspicious looking spots were cleaned out and pointed up, and the whole exposed surface given a plaster coat of mortar with steel trowel finish on the inside and wooden float finish on the outside.

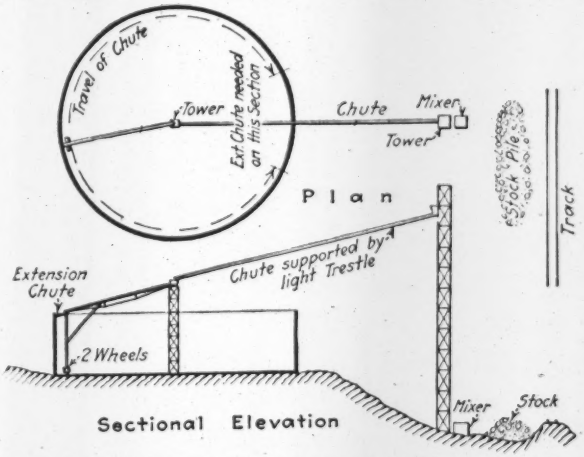
The concrete was placed circumferentially in layers about 12 in. in depth until the 6-ft. section was filled. The type of form used is not to be recommended, as in a thin section with such a large percentage of steel it is extremely difficult to secure good placing at the bottom of the deep form. In the construction of a similar tank by the writer in Colorado a few years ago the outside forms were built up complete, the inside studs and braces placed and the lagging nailed on immediately in advance of the pouring, so that there was never more than about 8 in. from the top of the form to the old concrete. The process can be made continuous by this method also.

The concrete was placed by means of a chute supported at its lower end by a ladder construction mounted upon a carriage having two wheels placed to travel circumferentially, and its upper end carried by a light tower placed in the center of the tank. The ladder construction enabled the chute to be carried at any desired elevation. This revolving chute was fed by a chute from a hoisting tower placed at the foot of the hill alongside a track from which material was handled. The skeleton sketch illustrates the plant sufficiently well.

The concrete was of approximately a 1:2:4 mix, the proportions used at the start of the walls being 1 cement, 2¼ sand and 3¾ crushed stone. These proportions were determined by G. C. Bunker, physiologist, as giving the densest mixture with the materials available. However, a trial proved that the mix was extremely difficult to properly place, owing to poor flowability into

forms containing such a large percentage of steel, so changes were made and graded gravel used instead of crushed stone. The final mix adopted was 1 cement, 2 sand and 4 gravel, graded ¼ in. to 2 in. in size, mostly of the smaller sizes. Tests on this mix showed a crushing strength of from 1,971 to 2,246 lb. (3 sets) at 29 days and an average of 2,898 lb. at 28 days.

It was desired to use hydrated lime as a waterproofing and to insure better placing, but none was available on the Isthmus. Upon completion the tank was filled with water, which gave it an overload of about 16 per cent, and kept filled for about two weeks. For the first few days numerous minor leaks developed, mostly in the form of seepages, which finally entirely stopped. The tank was then emptied and thoroughly dried and given a treatment on the interior in accordance with the speci-



HOW CONCRETE WAS PLACED IN PANAMA OIL TANK

fications of the Bureau of Yards and Docks, Navy Department, for concrete tanks containing fuel oil.

This consisted of a spray coat of a 7½ per cent solution of calcium fluo-silicate (1 gal. to 100 sq.ft.) for a height of 2 ft. up from the bottom. After 24 hours drying three coats of spar varnish with 20 per cent volatile mineral spirits (a hydrocarbon distillate) were sprayed on under a pressure of 60 lb. at intervals of 24 hours (1 gal. to 200 sq.ft. each coat).

Above the 2-ft. mark and to the top, the calcium fluosilicate was applied as above, followed at 24-hour intervals by two coats of glutrin painted on (1 gal. to 400 sq.ft. each coat). The tank was gradually filled with oil, with the development of a few minor leaks which quickly closed up.

The design and construction of the tank were carried out by the forces of the Building Division of the Panama Canal with Hartley Rowe, resident engineer; T. C. Morris, assistant engineer, and the writer as engineer-designer.

Will Need Men for Alaska Railroad

That 4,000 men will be wanted for work on Alaska railroad construction this summer is indicated in recent reports, following the appropriation of Congress. For the first time since construction began sufficient funds are available to undertake full operation of construction projects during the summer. The demand is particularly for experienced track, bridge and station-men. Application should be made through the Alaskan Engineering Commission, Bell Street Terminal, Seattle, Wash.

Prevention of the Red Water Plague

STUDIES of the corrosion of iron in its relation to the "red water plague," made at Pittsburgh, Pa., and at the Massachusetts Institute of Technology for a few years past, were summarized by Prof. William H. Walker, director Division of Industrial Co-operation and Research of the Massachusetts Institute of Technology, in a paper read before the New England Water Works Association recently.

Summarizing conclusions as to the causes of corrosion and their relation to house water pipes reached by studies at the Institute Professor Walker said:

"It was for many years thought that rust was formed by the direct union of the oxygen of the air, water and the iron. Now we know that such is not the case. In order to form rust the iron must actually go into solution in the water; if oxygen is present, it later unites with this dissolved iron separating as red rust. The formation of rust by the oxygen is thus the result of, not the cause, of the solution of the iron and its resultant corrosion. But careful study showed that the oxygen, which is normally dissolved in all water, plays a more direct and controlling part in this corrosion. Where iron dissolves in water, an equivalent or corresponding amount of hydrogen is set free from the water in the form of gas. This hydrogen covers the surface of the iron and protects it from further attack. But if oxygen be present, it unites with this hydrogen, destroys the protective covering and allows the solution of the iron to proceed. Speaking electro-chemically the hydrogen polarizes the surface of the iron, and the dissolved oxygen acts as a depolarizer. Where there is a complete absence of oxygen in a system, no appreciable corrosion of the iron will take place.

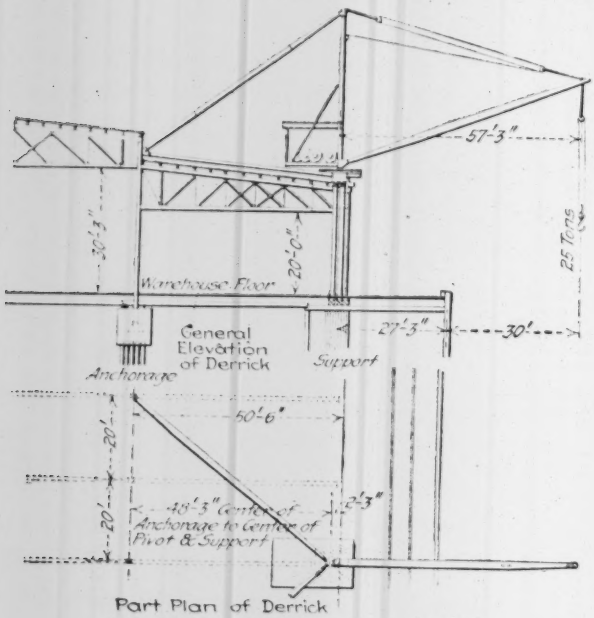
"The action of all the factors, causing corrosion, is greatly accelerated by rise in temperature. Hence a hot water supply system in which fresh (that is water fully charged with atmospheric oxygen) hot water is constantly passing through, is a most vulnerable structure. But since oxygen is consumed in the process of corroding iron and forming rust, it is obvious that if the water be held in contact with an iron surface it will soon lose all its dissolved oxygen and become inactive so far as further corrosion is concerned. Careful experiments have established the fact that the amount of corrosion, other factors being the same, is directly proportional to the free oxygen content of the water."

In the course of the paper brief reference was made to the "deactivators," for removing dissolved oxygen from water, which were first tested at Pittsburgh, Pa., four years ago and have also been tested in a Boston apartment house. In this apparatus the water from the street main, before reaching the house system, is passed through a heater that raises the temperature to 160 deg. F. and then through a storage tank containing iron sheets that have been chemically treated so as to cause rapid corrosion and finally through a filter. The oxygen in the water unites with the iron in the plates and such iron rust as is carried forward by the water is removed by the filter. By this means corrosion in house water pipes is prevented, the tests indicate. The expense of installing the Boston deactivator, Professor Walker informs *Engineering News-Record* was borne by the National Tube Co., of Pittsburgh, but the apparatus was operated and the conclusions regarding it were drawn by the Institute.

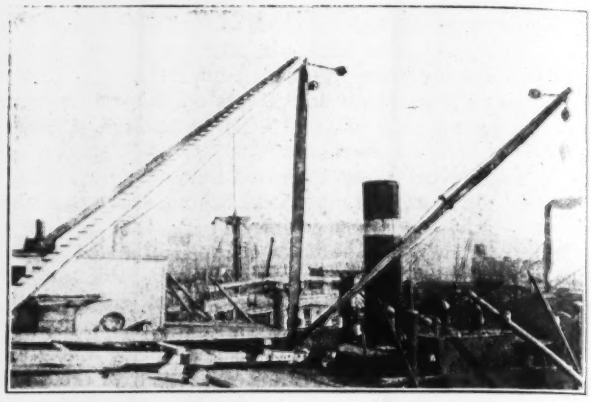
Stiff-leg Derrick with Wood Members Mounted on Pier Roof

Lack of Steel Resulted in Design of Terminal Freight-Handling Machine Out of Large Timbers and Use of Steam Winch Drive

TO AVOID the difficulty and the delay of getting structural steel in wartime, the Oregon-Washington Railroad and Navigation Co., used wood members entirely in building a 25-ton stiff-leg derrick on a pier shed roof at Seattle, Washington. No metal covering of any kind was put on the timbers, the only weather protection being heavy coats of paint and carbolineum or hot tar at joints. The base of the derrick is about 30 ft. above the level of the pier wharf and its weight is carried by the framed timbers of the pier shed structure, supplemented by such additional members and piling supports as were found necessary. The two stiff-legs of the derrick are 18 x 18-in. timbers, 72 ft. long. The mast is 20 x 20 in. in section and the two timbers lying on the shed roof, as well as the boom are 16 x 16 in. in cross-section. The stiff-leg members are reinforced with a 1-in. truss rod and the boom has four truss rods, 1 in. and 1¼ in. diameter.



GENERAL OUTLINES OF DERRICK

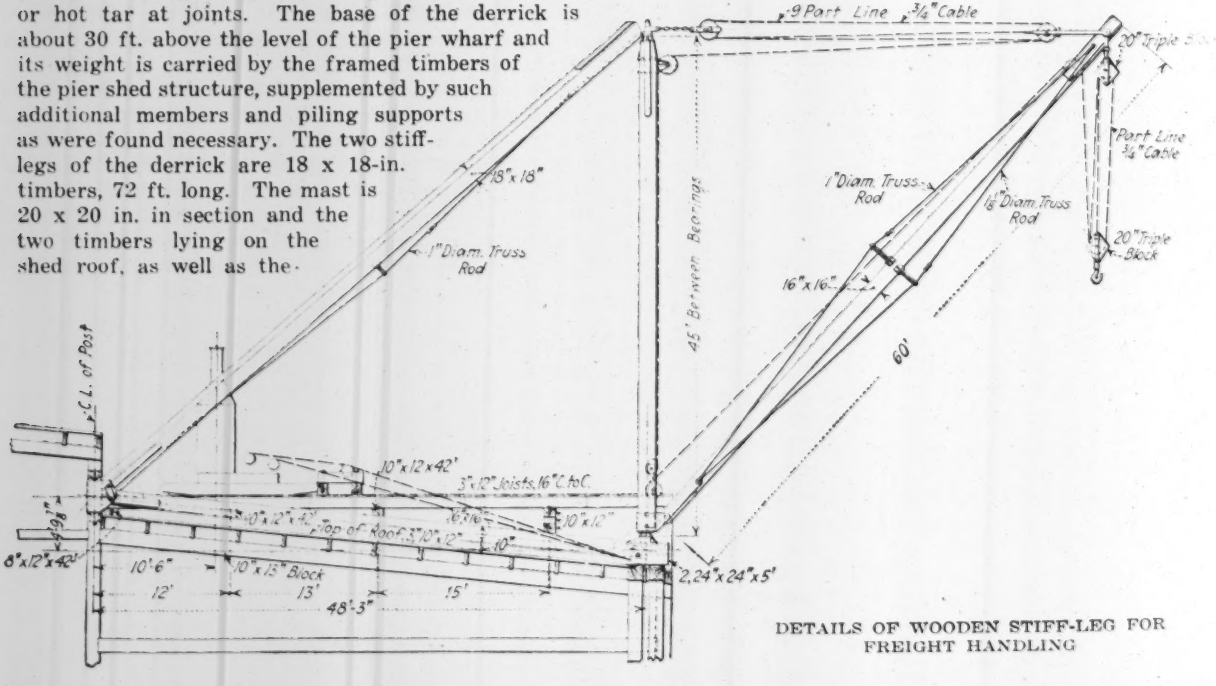


WOODEN STIFF-LEG MOUNTED ON PIER AT SEATTLE

The derrick would not be used frequently enough to warrant high first cost of electrical operating equipment, it was believed, so a steam winch of the type known throughout the Northwest as a "logging donkey," was installed to operate it. The boiler of the engine normally works under a steam pressure of 125 lb. per sq.in. On one occasion, when a 32-ton load had to be moved, the pressure was increased to 175 lb., with which the load was handled successfully.

The heads of the piles were notched to give the concrete a good bond, and a footing attached to the structural steel posts was imbedded in the concrete so that any upward pull would be resisted by the weight of the concrete blocks as well as by the frictional resistance of the piling.

The derrick was designed under the direction of S. Murray, chief engineer of the Oregon-Washington Railroad and Navigation Co.



DETAILS OF WOODEN STIFF-LEG FOR FREIGHT HANDLING

Need for Economic Location of Highways

Let Highway Locators Follow Railroad Principle—"Make Cost Per Ton-Mile a Minimum," Is Engineer's Appeal

By George F. Syme
Supervising Engineer North Carolina State Highway Commission

THE development of the modern highway has never before received such impetus as it is now receiving. The day for instructing the public in the advantages of good roads is past, and vast sums are now available for constructing them. The advent of the motor vehicle is, of course, the chief cause of this development, and it has brought us face to face with unlimited possibilities for commercial highway transportation, the volume of which will expand and develop, just as it has done on our railways. Our problem, therefore, is the same as that of the railway—to transport a maximum tonnage at a minimum cost.

We have seen railway tonnage increase year after year, and we have seen huge sums of money expended for heavier rails, greater motive power, better roadbed, and for decreasing resistance by the elimination or reduction of curves, grades, and distance. The problem of the railroad has ever been to reduce the cost per ton-mile of hauling freight, and that issue was attacked in the only practical way—by increasing the tractive power of engines and by reducing the resistance to moving loads. Their achievements are due to the fact, primarily, that the capital invested in the lines was privately owned, and that it must earn dividends or it would be withdrawn from the enterprise.

Railroad Engineers Highest Type

With this fundamental fact constantly before them, the companies could be depended upon to develop a high state of efficiency in the design and operation of their lines. They procured the highest type of engineering talent available, and they demanded results. Their locating engineers were men of talent and experience who knew that they carried a heavy responsibility and that they had to get results or nothing. For instance, the locating engineer in carrying his low-grade line over a bridge, would not fail to investigate the lowest gap or saddle in that ridge, nor would he cross a stream at any old place, nor break his grade line at random to help him over some local and relatively small irregularity of the ground. He was very cautious in the use, choice and location of curves—and as for a grade crossing of another line, or even of a highway this was not to be considered, save as a last resort. He knew that the economic operation of the railway depended primarily upon the intelligent location of his line; and that the cost per ton-mile of moving freight varied for a given motive power, directly as his curvature, rate of grade, etc., varied. He knew his problem. It was an economic location which he sought, not just any kind of location which he thought would "get by."

His greatest difficulty was of course to keep down the first cost of construction and on this he lavishly expended time, patience and energy, but he never lost sight of his operating cost per ton-mile. He could figure just how much of his employers' money he would be justified in spending to reduce grade, to eliminate or flatten a certain curve, to avoid a grade crossing, or to shorten his line. More than this, he knew that when he had finished his work, it would not be quickly and blindly accepted by his superiors. It would be closely studied and criticized by other experts, each of whom in turn would report his findings to those higher up, until finally it would be passed upon by the board of directors who represent the investors themselves.

It is thus evident that an ideal economic location, improved motive power and rolling stock, better rails and roadbed and better methods in maintenance and operation are the direct results of the demands of those whose money goes into the enterprise. We may, therefore, say that the development of our railway transportation problems may be safely left to those who have a personal financial interest at stake. It is a natural result fostered largely by the competition of other lines, each striving to increase its earnings. But what about our highway development? It must follow precisely the general method pursued by the railways.

Motor Truck Development

The rapid growth of highway traffic has already produced the heavy high-powered truck, that heavier tonnage may be moved. Truck development is yet in its infancy. It will continue to develop because men put their money into truck manufacture and because they have competitors to meet in the field. Trucks, like locomotives, demand a continuously improving roadbed, or surface. Here again private enterprise meets the issue. The engineers and chemists, employed by the various manufacturers of paving material "deliver the goods." The product of each concern must be constantly improved, or it will be driven from the market by its competitors. These engineers and manufacturers have studied closely the problems relating to hard surface roads and road construction. It is their specialty. They must understand these problems in order that they may produce satisfactory paving or surfacing material, and keep abreast of their competitors. Their enthusiasm is contagious, and their studies are interesting and helpful. The highway engineers of the country at large have been interested by the enthusiasm, claims and counter claims of the manufacturers, and as a result they too have contributed largely to the development of the hard surface. We may, therefore, for the present, rest assured that the development of the motive power and of the surfacing material will be pretty well taken care of and kept up to date by private enterprise.

These two developments will go a long way toward increasing the tonnage which may be transported over our highways. However, there appears grave danger that the greatest fundamental principle of highway development—the economic location of the highways—will not keep pace with the development of motive power and surfacing because of lacking incentive, due to the fact that public funds are used for construction and that the layman himself cannot differentiate between an economic location and a cheap location. As a taxpayer, he desires the latter and nothing else, except to have it pass through his farm, if he possesses one.

The development of the highway and of the railway are absolutely synonymous, both being based upon the same underlying principles—to move maximum tonnage at minimum expense, with a minimum initial construction cost.

Since the engineer is without the necessary incentive, is not conscious of a public demand for a high-class

location, and is handicapped on every side by having to contend with politicians, lawyers and county commissioners, it is no wonder that highway location has not kept pace with the highway accessories produced by private enterprise, or that it is not up to the present-day standard of railway location practice.

Situation Needs Careful Attention

However, this situation does not appear to be hopeless. Interest in this subject could be revived by a joint committee from the various organizations for the promotion of highways, co-operating with the United States Bureau of Public Roads and with the several state highway departments. The subject is strictly technical and demands close study. The general principles are similar to those applied to railway location and the ton-mile may well be adopted as the unit on which to base computations.

Commercial and other motor transportation is yet in its infancy, and our knowledge of the amount of tonnage to be hauled in the future over a given route is very vague. We know, however, that it will increase rapidly over a properly located and constructed road. It may be that data have been collected on some such roads already in existence. At any rate records could be kept showing this tonnage and its annual increase, from which a profile or curve could be plotted indicating future increase. Also, by a little research and effort, data could be collected and tabulated giving the cost per ton-mile for moving loads over various types of surfaces. With this information, even approximate, with our present knowledge of grade resistance, of the tractive power of motors, and the knowledge that curvature, rise and fall, grade crossings and distance have negative values which may be at least approximated, we would be in a position to locate our highways with more satisfaction and credit to ourselves and with the comforting knowledge that the public was getting value received for its expenditures.

Space does not permit reference to drainage, maintenance or construction details, nor is such reference necessary here, for fortunately these matters are already receiving a goodly amount of attention from the profession. Many of our highways, however, are so poorly located that proper drainage and maintenance are impossible.

It is the writer's belief that unless we make the necessary research, secure the data, correlate it and make it available for practical application, and unless we otherwise stimulate interest in highway location the resulting financial loss, due solely to poor location, which will become more and more apparent as the traffic increases, will reflect shame upon our profession. Are we not in duty bound to see to it that public funds invested in our highways and entrusted to us for proper expenditure should yield maximum returns to the public, just as we would have done had it been a private enterprise?

It is the writer's earnest hope that some competent authority in the very near future will give us a practical treatise on "The Theory and Practice of Highway Location," which will bear the same relation to our infant highway development that Wellington's great masterpiece bore to the early development of the railway, and the need for this is imminent, for we are building the highways now.

There is much food for thought and a wholesome lesson to be learned by studying the rapid growth and development of our railways. Their engineers had no precedent to guide them, but they solved their problems satisfactorily. They have shown us the way and we should either follow it intelligently or else devise a better one. How much more phenomenal has been the growth of highway transportation and to what limits will it reach!

Hudson Pier Encroachment Authorized by Secretary of War

ON DEC. 16 the Secretary of War approved the revision of the pierhead line in the Hudson River in in lower Manhattan, which straightens out a part of the line there, so as to encroach on the channel a maximum of 93 ft. The line revision extends from Pier 2 to Pier 9, in a district where at present the piers are too short to accommodate transoceanic steamers. Inasmuch as the present plan for the development of the harbor contemplates the removal to the East River of all the low-draft steamers now using the lower Hudson, thus making available more pier space for the deep-draft vessels which can only use the deeper Hudson, the Department of Docks of New York City asked the Harbor Line Board to establish the new line to permit the extension of the piers. This board recommended to the Chief of Engineers that the modification asked for be approved.

In reviewing the case, the Chief of Engineers continued the policy of the Corps of Engineers in the matter of pier extensions in New York City, and concluded that sufficient reasons to justify the change had not been presented. It was the Chief of Engineers' contention that while the proposed extension might not in itself be serious, it was a part of the history of New York Harbor that such extensions are only part or continuations of small encroachments which have resulted in the aggregate in the narrowing of the channel of the river to a fractional part of its original width, so that he felt in this present case that if the modification were approved it would be only a short time before there would be an application for the straightening of the harbor line from its present southerly limits to some point well to the northward, so as to eliminate the re-entrant angle caused by the proposed modification, and that the process would be repeated indefinitely.

In returning the case to the Chief of Engineers the Harbor Line Board amplified its previous recommendations by giving the reasons for its action. The board stated that it took full cognizance of the facts as advanced by the Chief of Engineers but that it felt that the imperative demand for longer piers in this part of the river was so great that it could not do other than to recommend the pier extension, inasmuch as it was impossible to extend the piers inland because of the expensive real estate located on the marginal streets, one of the structures being the well-known Whitehall Building, thirty stories in height. The board further thought that conditions were such that there would not be much danger of a continuance of the encroachment by straightening out angles in this section.

As the reasons for the change, with fuller details, were reviewed by the Chief of Engineers as ample justification for the modification, the papers were presented to the Secretary of War, with favorable recommendation on Dec. 13, and the change was approved by him on Dec. 16, 1919, without comment.

Is the Railway Employee Overpaid and Underworked?

By Charles Whiting Baker
Consulting Editor *Engineering News-Record*

It is well known that very large increases in wages have been made to railway employees; and that these large increases are chiefly responsible for the great falling off in railway net earnings. There is a general belief that the railway employee is drawing more pay than he is fairly entitled to and doing less work.

When the Plumb plan was presented to Congress last summer, the heads of the railway brotherhoods declared

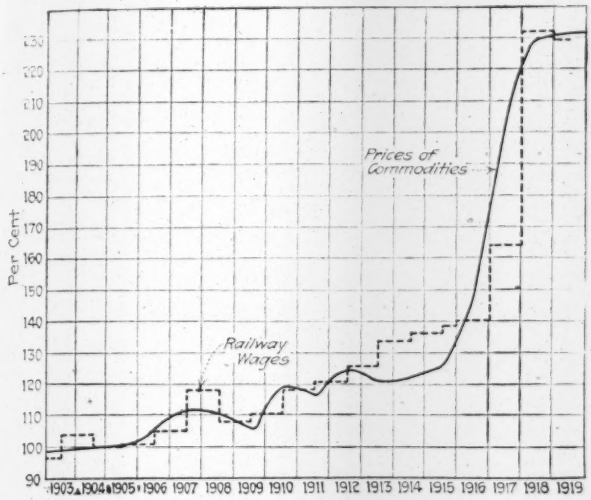


FIG. 1. INCREASE IN COST OF LIVING (R. G. DUN & CO.'S INDEX FIGURES) AND RAILWAY WAGES

(Percentage of increase for both prices and wages is the increase over the average of prices and wages for the three years, 1903 to 1905, which is taken as 100 per cent.)

that "the cost of goods mounts faster than the wage level." This statement was promptly challenged by the American Institute of Consulting Engineers, in a protest against the Plumb plan, which the Institute forwarded to President Wilson (see *Engineering News-Record*, Aug. 228, 1919, p. 405). In that protest the Institute said:

"Our investigations show that railway wages have increased faster than the cost of living, which is contrary to the statement made by the brotherhoods. The cost of living from 1914 to March, 1919, has increased 61 per cent, whereas all railway wages have increased 92 per cent."

If that statement is true, then the general public condemnation of the railway employee as a profiteer is, to a large extent at least, justified. If it is not true, then the error should be rectified so far as possible. The engineering profession aspires to aid in settling the controversies between capital and labor on a basis of justice to both. It can, of course, serve in that capacity only by dealing with absolute facts.

The statistics now available show that the increases in wages to railway employees since 1913 have not kept pace with the increased prices of goods. In 1916 and 1917, especially, prices mounted much faster than railway wages. It is true that in the two years since the Government took control of the railways very large wage increases have been made; yet these have been no more than sufficient to offset the decreased value of the dollar. The two accompanying diagrams show graphically the relations between the percentage of increase in railway wages and in wholesale market prices, one from 1913 to date, the other from 1903 to date. The figures for average railway wages are taken from the official reports of the Interstate Commerce Commission. The figures for wholesale prices are the "Index Numbers" published by R. G. Dun & Co. The Dun figures are adopted as coming from an organization wholly unbaised toward either capital or labor.

The Dun figures, it may be noted, are materially lower since 1916 than the Index figures for prices issued by the U. S. Bureau of Labor and used by the Association of Railroad Executives in a diagram comparing railway rates with increased living costs, published Dec. 15 in its bulletin, *American Railroads*.

It is fair to say that the error of the American Institute of Consulting Engineers was due, in part at least, to the use of statistics for the cost of living issued by the National Industrial Conference Board. This organization, as was shown editorially in *Engineering News-Record* Oct. 23, represents large employers of labor, and cannot be accepted as an impartial authority in determining the question of increased living costs on which wage adjustments now so much depend. Further than this, the Conference Board itself, in its later statistics, has greatly increased its figures for the cost of living. Its latest bulletin on Dec. 28 reports the increase in cost of living on Nov. 1 to be 82 per cent. It will be seen from the diagram above that this is just about equal to the increase in average railway wages since 1913.

And now, how about the absolute rate of pay? Is the average railway employee overpaid? The official records show that in 1903 the average railway employee earned $591 per annum or $49.25 per month. This includes, be it noted, all classes of employees, from railway presidents down to section men. Obviously, therefore, the wages of a large proportion of the employees are considerably less than this average. Fig. 1 shows that the increases in pay since that time have been no more than sufficient to offset the decreased buying power of the dollar. In other words, the average railway employee can buy no more and live no better now than he could 16 years ago, on a wage averaging $49.25 per month.

One of the best and fairest standards for judging of the wages of railways employees is the wage rate in

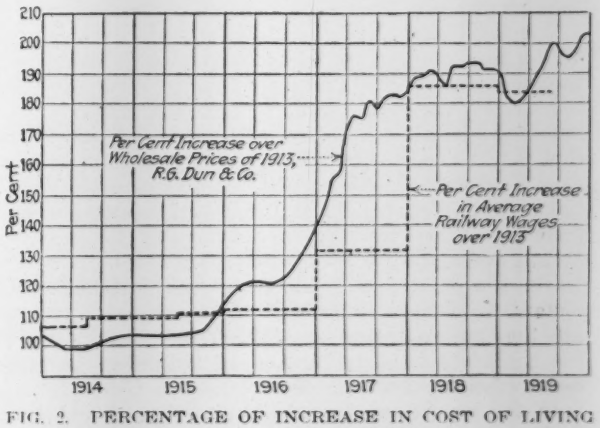


FIG. 2. PERCENTAGE OF INCREASE IN COST OF LIVING AND RAILWAY WAGES

other industries. The New York Bureau of Labor recently issued statistics showing that all factory employees in the state, a very large proportion of them girls and women, have had wage increases of 100 per cent since 1913 and are now earning $25 per week on the average. The average railway worker now has a wage of $27 per week and has had 83 per cent increase since 1913. There is no doubt that the skill, fidelity and responsibility required of the railway worker calls for a higher differential than $2 per week over the factory hand.

Finally, there is a widespread belief that railway employees under Federal administration have greatly slackened in industry and efficiency, and that the concessions granted to the workers have largely reduced the output per man. If this is true, then there must be a very large increase in the number of railway employees to take care of the enormous traffic the railways are now handling. The increase in the number of employees under Government control, however, has not been nearly proportionate to the increase in traffic. Seven years ago, in 1913, the railways had 1,815,000 employees and handled 301 billion ton-miles of freight traffic. In 1918 the railways had 1,821,000 employees and handled 409 billion ton-miles of traffic. In the first six months of 1919, the average number of employees was 1,852,000.

If there were serious deterioriation in morale and fidelity to duty among railway employees, an increase in the accident record would result. No such increase has been reported.

There are, without doubt, numerous cases where individuals and classes of employees are overpaid and underworked relatively to others; but these instances should not lead to unfair judgment toward railway employees as a whole.

Advise $18,000,000 Enlargement of Baltimore Water Supply

THE enlargement of the Baltimore water supply, recommended in the report by Nicholas S. Hill, Jr., and James H. Fuertes, consulting engineers, New York City, mentioned on p. 301 of *Engineering News-Record*, Feb. 5, 1920, includes the raising of the Loch Raven dam by 48 ft. at an estimated cost of $4,675,000, to give a total impounding capacity of 23,000,000 gal.; a new pumping station at Lake Montebello with a capacity of 185,000,000 to 200,000,000 gal. daily; the enlargement of the Montebello filtration plant by 52,000,000 gal. daily; the utilization and development of the Patapsco supply by making use of the present diverting dam of the Baltimore County Water & Electric Co. at Avalon and building new raw water basins, pumping machinery, filters and other equipment at that point; a new equalizing reservoir on high ground near Kenwood; a new high-service pumping station at Lake Ashburton, Walbrook; and various new supply mains, together with the reinforcement of the low, middle and high-service distribution systems. A water-waste survey, to be followed by the installation of meters, is also recommended. The estimated cost of all the improvements is $17,888,103, besides which the engineers estimate the cost of acquiring the properties of nine private water companies at $3,900,897.

In the report by the late F. P. Stearns and John R. Freeman (see *Engineering News*, April 21, 1910, p. 470) it was recommended that the Loch Raven dam be 97 ft. high, giving an impounding capacity of 21,000,000,000 gal. When constructed a foundation sufficient for a final height of 120 ft. was provided but construction was stopped at a height of 52 ft. (see *Engineering News*, Aug. 13, 1914, p. 331).

An outline of a report on water-works enlargements at Baltimore by Walter E. Lee, at the time water engineer, appeared in *Engineering News-Record*, Sept. 25, 1919, p. 631. At present William A. Megraw is water engineer, and J. W. Armstrong is filtration engineer of Baltimore. The Hill-Fuertes report has been referred by Mayor Broening to the New Annex Advisory Commission, Robert Garrett, chairman, for consideration. It should be understood that the report is a preliminary one and that the recommendations are subjected to change after more detailed study.

Impressions Here and There

A Senate Committee "Investigates" the Housing Corporation

CONGRESSIONAL committees in Washington are busy investigating the constructional activities of the war. At least the committees themselves call it investigating. The unprejudiced observer attending the sessions or reading the one report which has been issued finds more of the temper of the public prosecutor than of the unbiased investigator. In certain foreign courts procedure demands that the accused may be showered with abuse and contempt with the idea that innocence will rise superior to any slur. This method of discovering truth seems to appeal to legislative bodies.

Just now two of the engineering performances of the war are under trial: one, the whole activities of the Construction Division, the other, the design and construction of one part of the domestic war structure, the famous nitrate plant at Muscle Shoals. Doubtless these committees will be ready to crystallize the charges they have already formed, but until they do no comment on the unjust methods of their procedure is worth while. One other engineering activity, at least an activity in which engineers were largely concerned, has already been pilloried. That is the United States Housing Corporation and the report of the Senate Committee which conducted the court martial has been widely circulated. Unfortunately the protests of the accused have not gone quite so far nor has the unjustness of the accusations been exposed.

The charges of the committee are extensive and are incorporated in twenty-two separate findings. The findings overlap, however, and the charges can be reduced to much simpler terms. The committee indicts the corporation for building too elaborate and too costly houses and not the temporary type which, according to the committee, were ordered by the enabling act. It finds that construction was unduly slow so that very few of the houses were made available by the time the war ended. It criticises severely the tripartite method of design in which the architect, the engineer and the town planner jointly participated. It sees no reason

why the supervising architect of the Treasury Department was not called in to do the architectural work on all of the buildings. It claims that the architect's fees were doubled by some sort of arrangement by which the architect received "100 per cent extra on all of the so-called overhead expenses.

The committee finds some minor instances of unearned payments, which the vulgar mind might call graft, and condemns a number of the construction extras as being extravagant. It sees no reason why the corporation did not shut down all work immediately at the end of the war, nor does it understand why the corporation planned ahead of its appropriation. It ridicules the system of contract awards by which a score card of points, including experience, reputation, plant required, etc., was built up for the selection of the contractor. It denounces the loaning of $500,000 to what it pleases to call a nearly bankrupt water company upon the recommendation of the chief engineer of the corporation, who according to the committee had twice been a paid expert for the company. Finally it states that the corporation's own report that the average overhead allowance to engineers was only 1 per cent of the cost of the utilities involved is distinctly in error and that in fact the engineering fees amount to 5 per cent of contemplated work, or since only one-half the work was executed, 10 per cent instead of 1 per cent.

Of interest to the readers of *Engineering News-Record* are mainly the last two points of criticism. The charge against the former engineer of the corporation, one of the leading men of the profession and a man of undoubted integrity and famous reputation, is particularly nasty. The gentleman in question was never permitted to offer any defense of himself nor asked to do so. His standing in the profession was not considered by the committee. Entirely aside from that, however, the facts in the case are that the water company has deposited in the treasury of the Housing Corporation securities which today have twice the market value of the loan made to the company. Of these facts the committee was well informed. It merely chose to ignore them.

As to engineer's fees, it was notorious during the war that the Housing Corporation was getting a good deal for its money from its engineers. Complaints were continually made that some reform should be made to guarantee that the engineers would get fees at least equal to those which they could get in private work. There seemed to be no reason why this particular profession should be called upon to contribute its livelihood for patriotic reasons when other professions were at least getting a fair return for their services. These facts, too, are set forth in the testimony before the committee and in the report of the corporation. They did not just fit in with the committee's idea of what charges it should make.

Most of the other charges carry their own reply. Practically every one whose memory is not obscured by partisanship knows the temper of the American workman during the war. It does not necessarily impugn his patriotism to say that he went where the working conditions were best. Bidding for labor was unrestrained. Labor turnover reached unprecedented figures. It was, therefore, in the stress of the wartime condition considered necessary that the workman be provided not with unduly elaborate housing but with conditions which were at least equal to what he would hope for in a permanent home before or after the war. Temporary shacks got men for the two or three months cantonment construction, but they did not even hold them during that period. For the prospective long-time war condition a sane planning could only consider permanent housing and Washington in 1917 did not foresee the significance of November, 1918. This, too, the committee chose to forget.

For the elaborate and complicated system of designing which the committee criticises, it is difficult to prepare a brief. During the war there were many who felt stronger than they expressed that there was in the housing operations a lot of high thinking which could be well dispensed with. The building of the industrial villages for war purposes was essentially an engineering job in that it required the rapid production of a succession of approximately duplicate units. Certainly construction would have been expedited had the control lay with the engineer with such architectural help as was needed for the detailed design of the individual house and with the properly subordinated assistance of the so-called town planner and social worker. And this can be said without in any way going over to the extreme left wing of reactionaries who would conduct all housing operations under the noisome methods of the real estate speculator. At any rate the co-ordinate responsibility of the three types of designers tended to delay and confusion, while the necessarily idealistic nature of the gentlemen who engage in landscape art and town planning hardly lent itself to co-ordinate thinking or acting with the engineer who had to get things done. In this particular charge the committee has about its only solid basis of facts.

The other charges are comparatively unimportant. They were dragged in to make a general case. Probably there was graft in all the Government work during the war. Human nature is human nature war or no war, and the hurried conditions of 1917-1918 permitted laxity beyond that in normal times. Such laxity should doubtless be condemned. Grafters, if there are such, should be prosecuted, and if the committee had confined itself merely to such cases of this sort as it could discover it would not have attacked the housing performances of the Government very much.

The contract system of the Housing Corporation was by no means perfect. As an emergency form, however, it bears comparison with any other emergency form which could have been devised. It resembles in its essential working the form since advocated by a number of prominent men in the construction field as a permanent institution, and it served very well to select suitable contractors for work which, from its very nature, could not be submitted for lump-sum bidding. That it lent itself to favoritism and to an excess of cost over estimate is a charge common to any of the cost-plus contract forms which numerous contractors' organization are promoting in these days of peace.

The United States Housing Corporation had its many faults; so did all of the war-time organizations. That they must be subjected to grilling seems inevitable under our form of government. But if the critics really want to expose evils or to insure the avoidance of future mistakes they can take the Senate Committee on Public Buildings and Grounds as a fine example of how not to go about their work.

Washington, D. C.

ENGINEERING LITERATURE

A REVIEW OF BOOKS AND A LISTING OF NEW PUBLICATIONS

We Resume Giving Prices of Books

For some months past the prices of books noted in these columns have been omitted, owing to a ruling of the Post Office Department that the mere giving of the price of a book constitutes advertising (see *Engineering News-Record*, Aug. 21, 1919, p. 379). Under this absurd ruling if the price of a book were given it became necessary for the review to be stamped "Advertisement" and a copy of the issue containing the review filed at the New York Post Office. In addition, an extra zone postage rate had to be paid on the pages so stamped. *Engineering News-Record* was not stopped from giving book prices by the petty matter of additional postage and various incidental inconveniences, but it went against the grain to stamp as "Advertisement" material printed in its reading pages which was in no sense whatever such. For the convenience of its readers, however, *Engineering News-Record* has concluded to swallow its pride and with this issue it resumes giving book prices—with the hope that before long the absurd ruling already noted, which has been made by the Post Office Department and not by Congress, will be revoked.

A Highway Construction Handbook

HIGHWAY INSPECTOR'S HANDBOOK—By Prevost Hubbard, Chemical Engineer, The Asphalt Association; Formerly Chief, Division of Road Material Tests and Research, Bureau of Public Roads, U. S. Department of Agriculture. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Flexible Fabrikoid; 4 x 7 in.; pp. 372; illustrated.

REVIEWED BY H. ELTINGE BREED
Consulting Engineer, New York City

Mr. Hubbard's "Handbook" is written for inspectors, engineers and contractors. To the last man of them who cares for his work it will be of value far beyond its cost. It tells the man on the job what to do and gives him a sufficient background of information to know how to do it.

The unusually clear type in which the book is set and a good system of cross-referencing according to the number of the topic enable a man to find what he wants quickly. If the style is at times a bit involved and difficult it will at least compel the close attention of the reader—an attention given because he is getting rock-bottom information in return for it. The frequent use of diagrams to replace the old tabular scheme of presenting figures—quantities, costs, etc.—makes vivid many computations and reduces the amount of arithmetic required on the job. The diagrams will release considerable time and energy for each inspector who uses them. For instance, in discussing "Volume Basis" Mr. Hubbard shows on a chart the varying gravity of rock with the corresponding varying weights per cubic yard for a given void content. Contractors will appreciate this because they can see, graphically presented, why it takes a larger tonnage of some kinds of stone to build a road than it does of others. The author says: "If a given weight of broken stone of 3.0 specific gravity will build 13 miles of road, the same weight of broken stone of 2.6 specific gravity will build 15 miles of road."

The book deals largely with inspection of pavements proper. After a description of earth, sand, clay, shell and gravel roads, it goes on to broken stone roads, telford and macadam. It unfortunately omits sub-base macadam. Much attention is paid to the various types of surfacing. Especially valuable are the sections on materials, which give illuminating geological data about the different stones used. Every little pebble has a history all its own that determines its qualifications for highway work. This Mr. Hubbard explains. With a few statements, however, some engineers might disagree. For instance, in Article 38, he says: "In cases of well known supply [of stone] from which the material has been tested and approved within one year, the preliminary sample may be omitted." But it should be noted that sometimes the quality of the stone varies so in the same quarry that where it is being extensively worked, as many as four samples a year, or even more, have been found necessary. Such differences of opinion of course arise in respect to the matter of any good textbook. No book can be swallowed whole, and no author would wish it to be.

The chapters on bituminous pavement are the best in the book. They omit only a few details—the desirability sometimes found in construction work of a difference in method in preparing the top course stone for the application of asphalt and of tar, the wisdom of putting down a paper lap at joints where the bitumen is poured with a pressure distributor, and the advisability of applying the bitumen to the stone fairly soon after it has been laid—and they contain a mass of material that the inspector will be glad to have at hand. Most valuable are Mr. Hubbard's statements, with the extensive material that he has here collected, upon the proportioning of materials. Anything approaching definiteness on this eluded subject is welcome.

The sections on brick and on cement concrete pavement are less ample than those on bituminous concrete. For instance, the author says that brick should be culled, but he doesn't explain the sprinkling method by which to detect the soft and porous ones. The sections in question indicate less practical experience with these than with other types of pavement, but the theory behind them is sound, and the information compact and helpful. Mr. Hubbard handles so successfully the material that he presents that it may be hoped that future editions will take up the inspection of drainage, curb and gutters, guard rails, riprap, leaching basins, laying of pipe, etc., that are likely often to cause difficulties to the people for whom this book has been written.

Blueprinting Practice

BLUEPRINTING—By John F. Friese, editorial assistant and draftsman, Manual Training Magazine. Peoria, Ill.: The Author. Cloth; 5 x 7 in.; pp. 56; illustrated.

Information on good and bad practice in blueprinting is contained in this book by Mr. Friese, which treats of a subject that is not frequently discussed in a popular fashion. Besides indicating what printing arrangements and equipment secure best results, the author has included valuable cost data in his volume.

Many-Sided Views on Great Problems

MODERN INDUSTRIAL MOVEMENTS (The Handbook Series): Selected Articles Compiled and Edited by Daniel Bloomfield, Author of "Labor Maintenance," Editor Handbook "Employment Management," etc.; With an Introduction by Meyer Bloomfield, Author of "Labor and Compensation," "Youth, School and Vocation," etc. New York: The H. W. Wilson Co. Cloth; 5 x 8 in.; pp. 377.

By using small but legible type the publishers have brought into a single handy volume a large number and variety of utterances on current industrial problems well selected and edited by Mr. Bloomfield. The main subjects represented are the Worker's Co-operative Movement; Syndicalism, Industrial Unionism and the I. W. W.; Shop Stewards; Scientific Management; Guild Socialism; Management Sharing; Bolshevism; Labor Parties; and Industrial Reconstruction Programs. A bibliography and an index have been provided.

The aim of the editor was to select his material so as to give all sides representation. In a number of cases he first gives a basic document—like the I. W. W. Preamble, the Constitution of the Russian Soviet Republic, and the International Charter of Labor—or else historical and expository summaries. Among the authors included are Bertrand Russell, R. F. Hoxie, Louis D. Brandeis, Nicolai Lenin, John Spargo, Maxim Gorky and Samuel Gompers.

The volume is well worth owning and reading by all who wish to have their eyes open as to the great industrial, social, and political movements of the day.

More Efficient State Government

NEBRASKA CIVIL ADMINISTRATIVE CODE: An Act Passed by the Legislature, 1919—Lincoln, Neb.: Secretary of State. Paper; 6 x 9 in.; pp. 461.

RETRENCHMENT AND REORGANIZATION IN THE STATE GOVERNMENT OF NEW YORK: Report of Reconstruction Commission to Governor Alfred E. Smith, Oct. 10, 1919—Albany: The Governor. Paper; 7 x 10 in.; pp. 419; two folding charts in pocket.

Nebraska has consolidated her state departments on functional lines and with an eye to simplicity and economy, all as laid down in the code noted above. Constitutional provisions, it appears from the second of the two volumes before us, leave some nine officers and boards outside the code, but the legislation of 1919 makes the governor the chief executive officer of the state, acting through these six administrative departments: (1) Finance, (2) agriculture, (3) labor, (4) trade and commerce, (5) welfare and (6) works. Each of these departments is in immediate charge of a single administrative head known as a secretary. The act provides for a budget, central purchasing, and a centralized uniform system of state accounting. The Department of Public Works takes the place of the State Board of Irrigation, Highways and Drainage and supervises state construction generally. The health work of the state is entrusted to the Department of Public Welfare.

The report of the New York Reconstruction Commission contains a plan for consolidating the present 187 offices, boards and commissions into 16 departments, mostly single headed. It also provides a budget scheme. Constitutional amendments needed to make possible some of the proposed changes are submitted. The departments of most interest to engineers are public works, conservation, health, and public service, the latter comprising the two utility commissions. The Department of Public Works would include the present state engineer, departments of public works, highways, and architecture, the canal board and various commissions.

Besides the reorganization plan submitted by the Construction Commission the report contains valuable reviews of consolidation of administrative departments and of budget activities in other states, a section on salaries and pensions of state employees and other data. There is also a brief report of an "Engineering Advisory Committee Appointed by Engineering Council," headed by George W. Fuller.

Both the volumes noted will repay close study by all interested in the improvement of our state governments, and which is a matter of deep concern to the large and growing number of engineers engaged in, and more or less directly affected by, state activities.

A Brief Survey of City Planning

NEW IDEALS IN THE PLANNING OF CITIES, TOWNS AND VILLAGES—John Nolen, Town and City Planner. New York: American City Bureau. Cloth; 5 x 8 in.; pp. 138, illustrated.

Mr. Nolen's brief, readable and inspiring outline of city planning is designed for the general reader, but deserves the attention of engineers and architects who wish an introduction to the subject. Some further idea of the character of the book may be gained from Mr. Nolen's statement that it was prepared for the Department of Citizenship, Army Educational Commission, for use overseas. Becoming unavailable for that purpose through the return of the A. E. F., the book was brought out by the publishers named above. At the close of each section well chosen references for the use of those who wish to go deeper into the subject are given.

Changes in "Compressed Air Magazine"

With its January number the *Compressed Air Magazine* appears in changed form, with Francis J. Tietsort succeeding W. L. Saunders as editor-in-chief, and Eugene P. McCorken, recently assistant editor of the *Engineering and Mining Journal*, as managing editor. Frank Richards continues as technical editor and Mr. Saunders is president of the Compressed Air Magazine Co., 11 Broadway, New York City.

PUBLICATIONS RECEIVED

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be obtained without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or, in case of books or papers privately printed, then to the author or other persons indicated.]

AMERICAN SOCIETY FOR TESTING MATERIALS: Proceedings, 1919—Philadelphia, Penn.: The Society. Cloth; 6 x 9 in.; illustrated. Part I—Committee Reports: Tentative Standards. pp. 799. Part II—Technical Papers. pp. 802; illustrated.

ARCHITECTURAL DRAWING PLATES—By Franklin George Elwood, Head of Department of Architectural and Mechanical Drawing. Vocational School, Mooseheart, Ill.: Peoria, Ill.: The Manual Arts Press. Paper; 8 x 10 in.; pp. 15; illustrated. Sample details for a house, followed by several floor plans and ending with an example showing how an elevation is drawn from a plan.

CENTRAL ELECTRIC STATIONS IN CANADA—Paper; 7 x 10 in. Part I—Statistics. Ottawa, Can.: Dominion Bureau of Statistics. Pp. 27; illustrated. Part II—Directory, 1919—By J. T. Johnston, C. E., Assistant Director of Water Power. Ottawa, Can.: Dominion Water Power Branch. Pp. 252; illustrated.

DELAWARE STATE HIGHWAYS. The Story of Roads in Delaware from the Days of the "Beasts of Burden" to "The Road to Tomorrow" Prepared and Published by the Clearing House of the Delaware State Program. Dover, Del. Paper; 7 x 10 in.; pp. 53; illustrated.

EXPERIMENT STATIONS OF THE BUREAU OF MINES—By Van. H. Manning. Washington, D. C.: Bureau of Mines. Paper;

6 x 9 in.; pp. 106; illustrated. 25c from Superintendent of Documents.

HEALTH OF THE TROOPS IN THE UNITED STATES DURING 1918—By Major George A Soper, Sanitary Corps, United States Army. Reprinted from the *Military Surgeon* of October, 1919. Address the Author, 130 W. 57th St., New York City. Paper; 7 x 10 in.; pp. 22.

INDEX NUMBERS AND SCORING OF WATER SUPPLIES—By Abel Wolman. Reprinted from the Journal of The American Water Works Association, Vol. 6, No. 3, Sept., 1919. Baltimore, Md.: The Author, c/o State Board of Health. Paper: 6 x 9 in.; pp. 12; illustrated

INTERNATIONAL ASSOCIATION OF INDUSTRIAL ACCIDENT BOARDS AND COMMISSIONS: Proceedings, 1918—Washington, D. C.: Bureau of Labor Statistics. Paper: 6 x 9 in.; pp. 224. 15c. from Superintendent of Documents.

INTERNATIONAL BOUNDARY BETWEEN THE UNITED STATES AND CANADA: Joint report upon the Survey and Demarcation along the 141st Meridian from the Arctic Ocean to Mount St. Elias—Washington, D. C.: Coast and Geodetic Survey. Cloth; 9 x 12 in.; pp. 305; illustrated.

THE LABOR AUDIT: A Method of Industrial Investigation—Washington, D. C. Federal Board for Vocational Education. Paper; 6 x 9 in.; pp. 47.

The opening sentence states: "A labor audit offers a method for the diagnosis of an organization's labor maladjustments."

MANUFACTURE AND USE OF CEMENT CONCRETE BLOCKS FOR LINING LARGE LIQUID FUEL RESERVOIRS ON THE NORTH WESTERN RAILWAY—By N. Pearce, Assoc. M. Inst. C. E., Executive Engineer. Simla, India: The Railway Board. Paper; 8 x 13 in.; pp. 6; folding diagrams.

MATERIALS AND METHODS USED IN THE MANUFACTURE OF ENAMELED CAST-IRON WARES—By Homer F. Staley, Metallurgical Ceramist, Bureau of Standards. Washington, D. C.: The Bureau. Paper; 7 x 10 in.; pp. 158; illustrated. 20c. from Superintendent of Documents.

MINERAL PRODUCTION OF CANADA—Report, 1918—Ottawa, Can.: Department of Mines. Paper; 6 x 9 in.; pp. 80.

NEW YORK CONSERVATION COMMISSION: Report, 1918—Albany, N. Y.: The Commission. Cloth; 6 x 9 in.; pp. 426; illustrated.

NORMAL PRECIPITATION IN UTAH—By J. C. Alter. Reprinted from "Monthly Weather Review," Sept., 1919. Washington, D. C.: Weather Bureau. Paper; 9 x 12 in.; pp. 4; illustrated.

THE PRIMARY AND SECONDARY ROAD LAWS OF IOWA: Chapter I—Procedure by Board of Supervisors, Under Primary Road Law; Chapter II—Statement of Condition of Primary Road Fund, April 19, 1919—Ames, Iowa: State Highway Commission. Paper; 9 x 12 in.; pp. 79.

PRINCIPLES OF GOVERNMENT PURCHASING—By Arthur G. Thomas. New York and London: D. Appleton & Co. Cloth; 6 x 9 in.; pp. 273. $3.

THE PRODUCTION OF COAL AND COKE IN CANADA, 1818—By John McLeish, B.A., Chief of the Division of Mineral Resources and Statistics. Ottawa, Can.: Department of Mines. Paper; 6 x 9 in.: pp. 40.

PUBLIC HEALTH WORK IN INDIA—By Harry N. Jenks, B. S. Assistant Engineer, California State Board of Health. Reprinted from "American Journal of Public Health," Vol. IX, No. 11. Paper; 7 x 10 in.; pp. 16; illustrated.

The first of the papers reprinted is entitled "The Caste System and the Sanitary Problem," and the second "A Review of the Nature and Progress of Sanitation." Mr. Jenks was recently sanitary engineer for a mining company in India, and contributed articles on his work there to *Engineering News-Record* of Jan. 23, 1919.

A READING LIST ON INDUSTRIAL RESEARCH: Reprinted from "Special Libraries," Jan., 1920. Bibliographic Series No. 3. Arthur D. Little, Inc., Chemists and Engineers, Cambridge, Mass. Paper; 6 x 9 in.; pp. 10.

REPORT OF PROGRESS IN WARM-AIR FURNACE RESEARCH—By A. C. Willard. (This Bulletin is the First of a Series on Warm-Air Furnace Research.) Urbana, Ill.: Engineering Experiment Station of the University of Illinois. Paper; 9 x 12 in., pp. 134; illustrated.

REPUBLIC OF CHINA: Statistics of Government Railways, 1918—Peking, China: The Ministry of Communications. Paper; 9 x 12 in.; pp. 134; illustrated.

STATE HIGHWAY COMMISSION OF NORTH CAROLINA: Biennial Report, 1917-18—Raleigh, N. C.: The Commission. Paper; 6 x 9 in.; pp. 86; illustrated.

STATISTICS OF CITIES AND TOWNS OF IOWA: Report on Municipal Finances for the Year Ending March 31, 1919—Frank S. Shaw, Auditor of State. Des Moines, Iowa: The Auditor. Cloth; 6 x 9 in.; pp. 270.

Contains a wide range of financial and physical statistics for all of the 105 cities and for 714 of the 788 incorporated towns of the State and the names of mayors, clerks and treasurers. Water-works and some other utilities are covered and salaries of the various officials are given.

TECHNISCHER LITERATUR-KALENDER, 1918—Mundhen, Berlin: Verlag von R. Oldenbourg. Cloth; 6 x 9 in.; pp. 640.

A well-arranged "Who's Who" of German authors and editors in the field of engineering and closely allied subjects.

UNION SCALE OF WAGES AND HOURS OF LABOR, MAY 15, 1918—Washington, D. C.: Bureau of Labor Statistics. Paper; 6 x 9 in.; pp. 295. 25c. from Superintendent of Documents.

Many figures are given for building and other trades in various cities and there are summaries comparing the 1918 figures with those of earlier years.

WHAT OF THE CITY?: America's Greatest Issue—City Planning, What It Is and How To Go About It To Achieve Success—By Walter D. Moody, Managing Director, Chicago Plan Commission. Author of "Wacker's Manual of the Plan of Chicago," etc. Chicago, Ill. A. C. McClurg & Co. Cloth; 5 x 8 in.; pp. 441; Illustrated. $2.50.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

A. A. E. Should Handle Non-Technical Work of Federated Engineering Societies, Says Secretary

Sir—A debatable question no longer exists as to whether engineers of the country should get together in furtherance of their non-technical interests. The attitude everywhere is not whether, but how shall this end be achieved? Some engineers evidently think that a sort of super-organization of the founder societies should be brought into existence, or perhaps a federation of all societies, but an increasing number are coming to the conclusion that the end will be best accomplished by using the well tried machinery at hand, designed for this purpose, namely that of the American Association of Engineers.

A striking omission occurs in the report of the Joint Conference Committee of the older societies, one which by its absence attracts comment throughout the rank and file of the profession; namely, the neglect to refer to the fact that the work proposed to be done has already been undertaken and is well advanced by the American Association of Engineers, with a membership now larger than that of any other national society. From all parts of the United States is coming the question, "Why has the Joint Conference Committee's report been silent on this vital question?"

In answer to this question and in the firm belief that the rank and file of the profession are waiting for such an announcement, the Secretary of the American Association of Engineers on Dec. 20, 1919, addressed the following letter to the governing bodies of the founder societies:

"The development of the opinion in the founder societies in favor of giving attention to the non-technical side of the engineer's life has led several members of each to ask the American Association of Engineers to write simultaneously to the governing bodies of these societies offering its service in problems of public and professional welfare and asking their co-operation.

"We have read the report of the Joint Conference Committee and believe that the American Association of Engineers, a successful going organization, is capable of carrying forward the non-technical activities recommended in the report fully as well and perhaps better than the organization recommended by the conference report.

"The activities of A. A. E. are confined to social and economic problems such as legislation, employment, compensation, political and civic endeavor. A. A. E. takes in everyone of good character in the engineering profession and seeks to mobilize all engineers for joint action. It gets its support from the man back home without any intermediate representation so that it is able to do the things that lie close home and that make living as an engineer worth while.

"If the founder societies elect to co-operate with A. A. E. in the work it is doing and in similar non-technical activities, it would be our understanding that such support would not be financial and would in no way

interfere with present prerogatives and privileges of the founder societies.

"This letter has been approved by our Executive Committee at its meeting Dec. 20, 1919. We are enclosing copy of our constitution for convenient reference."

Let us have full discussion. The great body of engineers who have given the matter thought evidently believe that the ends to be attained from the human side must be reached by a strong, well built and thoroughly democratic organization, devoted exclusively to these ends and organized for effective action in ways which the men of experience in human and political activities have found to be most effective. On the other hand, they feel that the purely scientific societies, organized for the investigation of natural phenomena and their application, which elect for their officers men distinguished by research and technical achievement, cannot by mere federation and delegation of power through complicated machinery achieve important results for the welfare of engineers as men and citizens.

Are you in favor of unity along the lines of the above letter? If so, write the editor of this paper, sending copies to the Secretary of the national technical society of which you are a member, and to the Secretary of the American Association of Engineers.

C. E. DRAYER,
Secretary American Association of Engineers,
Chicago.

Street Snow Removal Problems

Sir—In your issue of Jan. 29, p. 221, the article on "Rotary Snowplows Clear Streets in Canadian Cities" contains some interesting statistics regarding the cost of removing snow. It brings to my mind the importance of giving sufficient detail for an intelligent comparison of the costs of snow removal. Unlike other substances that require disposal by moving, snow varies widely in weight, and it is weight that is of first importance in comparing costs of snow disposal.

A common nomenclature for reporting snow precipitations should be adopted. I suggest the following method for reporting snow falls: Let a 6-in. snow fall, weighing say 8 lb. per cubic foot in its natural precipitated state, be reported as a 6-in.-8-lb. snowstorm. Shrinkages cannot be properly taken into account without a knowledge of the depth and weight. Temperatures preceding a storm and during the time of disposal should be recorded at frequent intervals.

As for the problem in general: There seems to be a misconception as to whether time or cost is the more important in any system or device for snow disposal. The value of time in dollars depends on local conditions, and is a much involved item. If all the money necessary for keeping a street free from snow is available, and it takes a week and in most cases longer to get to the street to clean it, the money spent there is small compared to the amount that would be justified if it were possible to clean the street within 24 hours.

For any snow-disposal system or device to be practical, it must embody absolute availability in time of need, without dependence on large numbers of laborers or mechanics; be quick in its action so as to save time, and economical, so as to justify the investment for its installation. Any system that falls short of these requirements does not justify its installation.

The probable availability of any system for snow disposal must be considered with due regard to the problems the system itself introduces. If the system depends upon its functioning on labor, skilled or unskilled, there must be assurance that it will be available in time of need. If the system depends upon fuel and labor, it must be certain that the fuel can be delivered during or following a storm, under the severe conditions the system is trying to remedy.

To have melting machines in numbers sufficient to handle a storm, without being able to distribute them in times of need, or not having labor or fuel to keep them going, would be a calamity, inasmuch as the dependence placed upon the machines precludes making other arrangements to handle the snow.

This vital problem is still the same old annual sore spot, except that it is more acute now than ever because of the labor shortage, and unless it is solved soon along lines where labor is not the predominating factor it promises to surpass the worst that has yet visited New York City.

L. DAVIDSON,
New York City. Civil Engineer.

[Observers of the U. S. Weather Bureau now report both the depth in inches and the water equivalent of freshly fallen snow, but surveys of snowfall in the streets are not made. Apparatus devised by the Weather Bureau for obtaining snow densities by direct reading was described, with historical notes on its development, by B. C. Kadel in the "Monthly Weather Review" for October, 1919. It appears that this apparatus has been used only now and then in cities, but for some years past it or similar devices have been employed in snow surveys over wide areas in the Far West. (See *Engineering News*, May 29, 1913, p. 1110, and *Engineering News-Record*, Oct. 23, 1919, p. 767). These samplers consist of a graduated sampling tube with a cutter on the lower end and a spring balance giving water equivalent depths. In the "Monthly Weather Review" article cited above, tubes with inner diameters of 1.5 to 5.94 in. are described, but Mr. Kadel's latest design shows a diameter of 2.655 in. The tube described in our issue of Oct. 19, 1919, p. 766, has a diameter of 1⅞ in. with a 1½-in. cutter. In the Western surveys the density of compacted rather than newly fallen snow is desired and far greater depths are observed than would be encountered in city streets.

If officials concerned with snowfalls in cities were to unite in a request to the U. S. Weather Bureau for density measurements of freshly fallen snow it seems probable that they would be made and reported hereafter.—EDITOR.]

Some Fundamentals of Tainter Gate Design

Sir—The writer, in the few designs he has made for tainter gates, has been confronted by a lack of literature on the subject. If such data is existing or not, a discussion may help either to learn its whereabouts or to bring out new ideas.

In this connection, the writer is ready to start what he hopes will be a discussion by making some statements relative to his experience. They are as follows:

1. In most cases, the economical length of gate seems to be about 25 ft.

2. A very good radius (outside face of lagging to center line of pin) lies between 16 ft. and 18 ft.

3. The pin should be in the same horizontal plane as normal head water.

4. The timber lagging (or the steel skin plate, if timber is not used) should extend about 2 ft. above normal head water.

5. The gate arms should parallel the pier sides, the center line of arm being not more than 6 in. out from face of pier. (A notable instance to the contrary is at Badin, N. C., where the tainter gate arms are formed of a pencil of angles running from the pin at an angle with the pier face to about the quarter point of the gate span.)

6. A very good seal between the spillway and the gate is formed by fastening a toothed plate onto the top of the timber which is embedded in and runs along the spillway crest. When the gate is closed, the teeth engage a timber attached to the bottom of the gate.

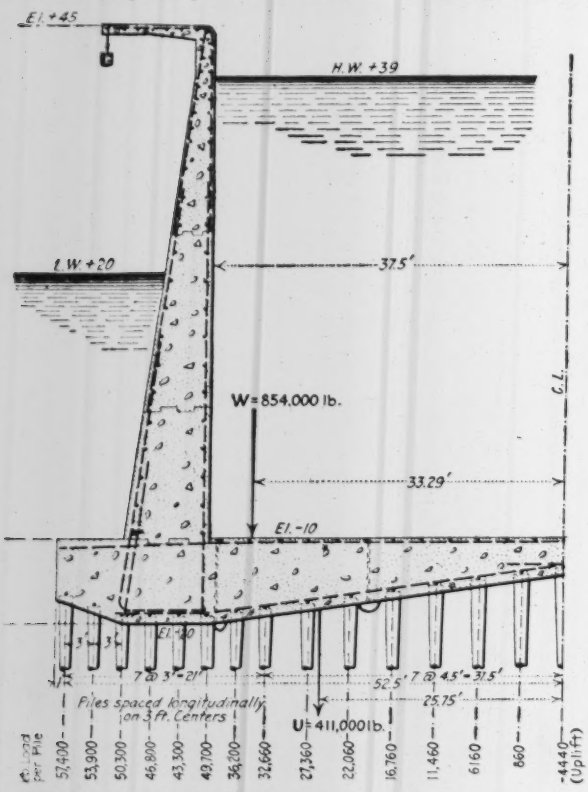
7. Between the gate and the pier sides, the usual seal of rubber belting pertains.

AUSTIN H. REEVES.

Charlotte, N. C.

Pile-Load Distributions Under a Lock

Sir—The problem of spacing piles to take care of eccentric loading, discussed in *Engineering News-Record*, Oct. 9, 1919, p. 698, by Edward P. Arneson, is similar in principle to one met in designing the base



DISTRIBUTION OF PILES UNDER HALF OF LOCK AT NEW ORLEANS

slab of different portions of the reinforced-concrete lock for the New Orleans Inner Harbor Navigation Canal. Here, however, the base was so wide and the number of cases of design gave enough variation in pile loads so that the spacing used was nearly uniform. The following method was used to insure against overloading the critical piles. The figures are taken from the design of the portion of the lock known as the light section.

One-half of this structure is assumed to act independently, except that thrust meets thrust in the center at El. —12.0. Under this assumption, and assuming high water in lock, we have for 3 ft. length 53.5 ft. wide a weight of 854,000 lb., the resultant being located at a point 33.29 ft. from the center line of the lock. This force is met by 14½ piles, spaced as shown on the drawing. For greater convenience in computing, the outer pile, 52.5 ft. from the center, is taken as the reference pile, and its load is taken as P lb. A constant negative increment of f lb. per ft. for each pile is assumed as the second unknown, so that the load on a pile n feet distant from reference pile is Pnf. The moment computed about the reference pile is 19.21 × 854,000 or 16,405,000 ft.-lb. Deducting buoyancy, 53.5 × 3 × 40 × 64 or 411,000 lb. acting 25.75 ft. from this reference pile, we have remaining a force of 443,000 lb. and a moment of 5,921,000 ft.-lb. to be met by the piles alone.

Then by the arrangement of figures in the accompanying tabulation the equations of equilibrium are easily found. The first column contains the number of piles at each point; the second, this number times the distance from reference pile; the third, this number times the square of the distance.

1	0.0	0.0	1	30.0	900.0
1	3.0	9.0	1	34.5	1,190.25
1	6.0	36.0	1	39.0	1,521.0
1	9.0	81.0	1	43.5	1,892.0
1	12.0	144.0	1	48.0	2,304.0
1	15.0	225.0	½	26.25	1,378.12
1	18.0	325.0			
1	21.0	441.0	Totals, 14.5	330.75	11,095.87
1	25.5	650.25			

From these totals and the previously obtained load 443,000 lb. and moment 5,921,000 ft.-lb. we write the two equations:

$$14.5P - 330.75f = 443{,}000$$
$$330.75P - 11{,}095.87f = 5{,}921{,}000$$

Solving we have $P = 57{,}400$

$f = 1{,}178$

This gives pile loads starting at the left at 57,400 lb. and diminishing, as shown in the drawing, by decrements of 1,178 lb. per ft. to an uplift of 4,440 lb. at the center pile.

MARSHALL G. FINDLEY,
Asst. Designing Engineer Board of Commissioners of the Port of New Orleans.

Forest Snowfalls and Runoff

Sir—J. C. Stevens discusses in *Engineering News-Record*, Jan. 15, p. 150, the effect of forests upon watershed yield, stating that such areas dissipate a greater proportion of the snowfall than do open fields, this conclusion being based upon "snow densities" as given in your issue of Oct. 23, 1919.

Several reasons suggest themselves as to why snow from open fields might be found to have a greater water content than an equal depth of snow in a forest. That, however, can hardly be considered a reason for assuming that the evaporation from the forest area had been greater than the evaporation from the open field. Considerations other than the water content of the snow in the two areas, may have a decided effect upon this problem, as, for instance, the summer evaporation and the transpiration from grasses and trees, also the rate at which the snow gives up its moisture, either to the ground or to streams.

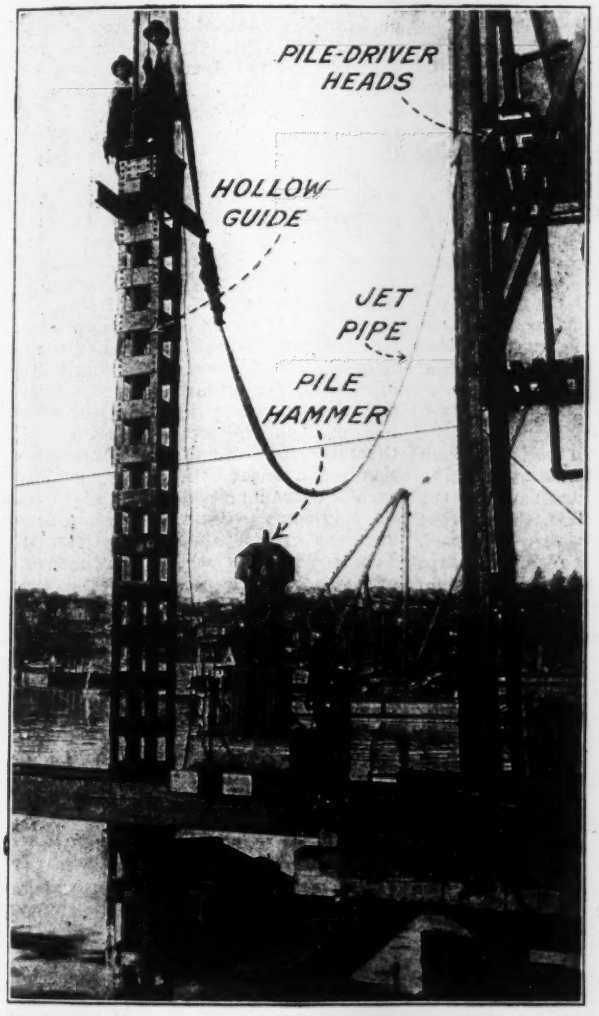
T. DEL COFFIN,
Katonah, N. Y. Civil and Sanitary Engineer.

HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Drop Hammer Works Under Water on Bridge Foundation Piles

IN DRIVING piles for the foundation of the bascule bridge carrying Eastlake Ave. over the Lake Washington canal at Seattle, Wash., the drop hammer was lowered under water instead of being kept above the surface by placing a follower upon the pile head. This method



DUMB-BELL PILE HAMMER IN HOLLOW GUIDE WORKS IN DEEP WATER

was adopted by the contractors as being less expensive than the use of a follower in deep water and the apparatus was similar to that which had been used in foundation work along the Atlantic coast.

A hollow guide for the drop hammer was built up of four corner angles with bottom plates on the four sides, leaving about 60 per cent of the area open, as shown in the accompanying view. The 5,400-lb. hammer was made specially to fit in this hollow guide and was provided with grooves on the opposite sides to accommodate the jet pipes inside the guide. This hammer was dumb-bell shape, with an enlarged section at top and bottom connected by a smaller shank. The maximum depth of water over the pile heads when driven was 3.8 ft.

About 676 piles were driven in this way, ranging from 28 ft. to 62 ft. a length. After excavation of the site by a suction dredge it was enclosed by a line of piles with caps, on which were laid out intersecting range lines to indicate the location of the foundation piles. Timber stringers supported the piledriver, the hollow guide being held rigidly between these stringers with its lower end close to the bottom of the footing. This was done under the direction of A. H. Dimock, city engineer, and F. A. Rapp, city bridge engineer. The contractors were Booker, Kiehl & Whipple, Seattle.

Publicity for the Contractor

A NEW idea in publicity for construction work has been instituted in the building of an extension for Selfridge's, the large American department store in London. A gangway is laid across one end of the excavation and the public is invited to pass over and view the foundation work. To assist the non-technical man in comprehending what he sees, all the machinery is labelled conspicuously: "concrete mixer," "crane," etc. This is in decided contrast to the more usual practice of putting up a tight fence and leaving a more or less curious public to peep through occasional and unsatisfactory knot holes. The publicity idea has elements of value to the contractor and—in this case—to the owner also, who instituted it to advertise his store and its activities.

Night Road Work Successful with Artificial Light

CARBIDE lights set on posts 4 ft. high spaced about 100 ft. apart, enabled night construction at reduced cost on the Hancock-Dollar Bay highway in northern Michigan. Construction began July 23 and as after Aug. 1 in this latitude night frosts are frequent and the warm hours during the day when tarring is possible are few, it was determined to employ night shifts so as to complete the work before cold weather. The shifts arranged were 4 a.m. to 1 p.m., 1 p.m. to 10 p.m. and 10 p.m. to 4 a.m. There was darkness only during the night shift and then for only four hours when artificial lighting was necessary. The construction was penetration macadam, 15 ft. wide in a 3-in. excavation on a 24-ft. roadbed. The night shift was employed exclusively in handling stone by motor truck and spreading it, and the force consisted of three trucks and drivers and one man helping to dump and spreading. The trucks averaged about seven loads each per shift with a four-mile haul. The carbide lights arranged as stated were moved along as the stone laying progressed. There was no traffic to interrupt, and T. A. Coon, engineer, Houghton County, states that the efficiency of the men on the night shift was greater and the unit cost less than with daylight work. So successful was the night work that it will be employed during 1920 wherever the occasion arises.

NEWS OF THE WEEK

New York, February 19, 1920

Senate Committee Considers National D. P. W. Bill

Members Express Keen Interest in the Arguments Advanced by Prominent Engineers in Hearing

(Washington Correspondence)

Supporters of the Department of Public Works bill are greatly encouraged by the friendly attitude of members of the Senate Committee on Public Lands by whom they were given a hearing Feb. 11. At the outset the members of the committee were rather apathetic but the interest increased as the hearing progressed. At its close Senator Norris, who was presiding in place of Senator Smoot, the chairman, stated frankly that the proposition had aroused the keen interest of the committee. He spoke favorably of the spirit of the men who appeared before the committee and of their very evident self-sacrifice in their efforts to secure the legislation.

The committee seemed to be impressed with the character of the bill's proponents present, a list of whom is as follows: M. O. Leighton, chairman, National Public Works Department Association; J. Parke Channing, New York City, chairman, Engineering Council; Prof. G. F. Swain, member of faculty, Harvard University; F. L. Cranford, president, General Contractors' Association; F. M. Gunby, formerly Colonel, Construction Division, U. S. A.; Charles Whiting Baker, consulting editor, *Engineering News-Record;* Francis Blossom, formerly chairman, War Department Board of Review of Construction; Charles W. Whittaker, editor, *Journal,* American Institute of Architects; Dr. W. F. Willoughby, director, Institute for Government Research; Major C. T. Chenery, secretary, National Public Works Department Association; and Philip N. Moore, past-president, American Institute of Mining and Metallurgical Engineers.

Means of Reducing Appropriations

Mr. Leighton made the introductory statement to the committee, reciting the well-known arguments for the creation of a National Department of Public Works. He emphasized the importance of such a creation in the interest of administrative economy. He named it as one of the most effective ways to reduce appropriations. Mr. Channing pointed out that public works are strictly technical in character and require the services of skilled personnel for their efficient construction and operation. Prof. Swain argued

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New York Snow-Bound

The pictures on the opposite page, taken a week after the first fall of snow, give an idea of how the recent storm in New York City paralyzed traffic. Shortage of emergency labor to supplement the regularly employed forces of the Department of Street Cleaning delayed the clearing of the streets and caused a complete shutdown of the street railway lines. Traffic difficulties were caused chiefly by the fact that the snow packed down and froze into a thick ice layer, which, under the influence of traffic and periodic thawing spells, developed pot-holes or craters such as those shown in Photo 11. Thousands of motor and horse-drawn vehicles were stalled when their wheels sank into these deep, icy pits.

A novel sight was presented by a traction excavator used by the Anoroc Engineering & Contracting Corporation for loading snow onto motor-trucks. Photo 8 shows this Keystone grading rig with ½-cu.yd. skimmer bucket at work on Broadway near 14th St. It handled the snow effectively, but was not supplied with enough trucks to enable it to work to capacity. Delays of half an hour between the departure of a loaded truck and the arrival of an empty were observed. The output was 272 cu.yd. on the first day; this was increased to a maximum of 439 cu.yd. on Feb. 14.

Great numbers of horse-drawn vehicles were on the streets after the storm. Many were pulled by four and some by six-horse teams.

The removal of snow from the streets proceeded very slowly. Sewers were employed to some extent for disposal, but the progress as a whole was not rapid enough to offer much relief to the almost complete traffic tie-up which extended over a period of many days.

Some phases of the traffic and snow problems are discussed in an editorial on another page.

Montreal Water-Works Strikers Return to Work

The union employees of the Montreal water-supply plant who went out on strike Jan. 1 have effected a reconciliation with the Administrative Commission of that city and returned to their posts at the several pumping stations. Each side made concessions. The men agreed to have their wages adjusted by a committee and to resume work pending the adjustment. The men are to be paid according to a scale of wages equaling that paid for similar work by private corporations.

Military Engineers' Society Is Being Organized

Association of Technical Men With Service in Any Branch of the Army Is Approved by Chief of Staff

A national association of present and former officers of engineers and civilian engineers who have served in any arm or branch of the U. S. Army—Engineers, Ordnance, Signal Corps, Infantry, Cavalry, Artillery, etc.—to be called the Society of American Military Engineers, is being organized by a committee in Washington, appointed by the Chief of Engineers. The society's objects are to promote the science of military engineering and to foster the co-operation of all arms and branches of the service, and of civilian engineers, in that science. The objects and a provisional constitution of the society have been approved by the Chief of Staff.

A board of engineers was appointed Nov. 1, 1919, by the Chief of Engineers to consider and report on the feasibility of a technical organization of officers and civilian engineers experienced or interested in military engineering. At the same time the Chief of Engineers required a letter-ballot for or against such an organization from all Corps of Engineers officers and temporary engineer officers then in the service. The vote was overwhelmingly in favor of the proposed society.

The board then resolved itself into a Committee on Organization. Its members are: Colonels F. V. Abbott, Charles Keller and G. A. Youngberg; Majors George B. Pillsbury, George R. Spalding, P. S. Bond, Max C. Tyler, John C. Kingman and David McCoach, and Captain Douglas L. Weart.

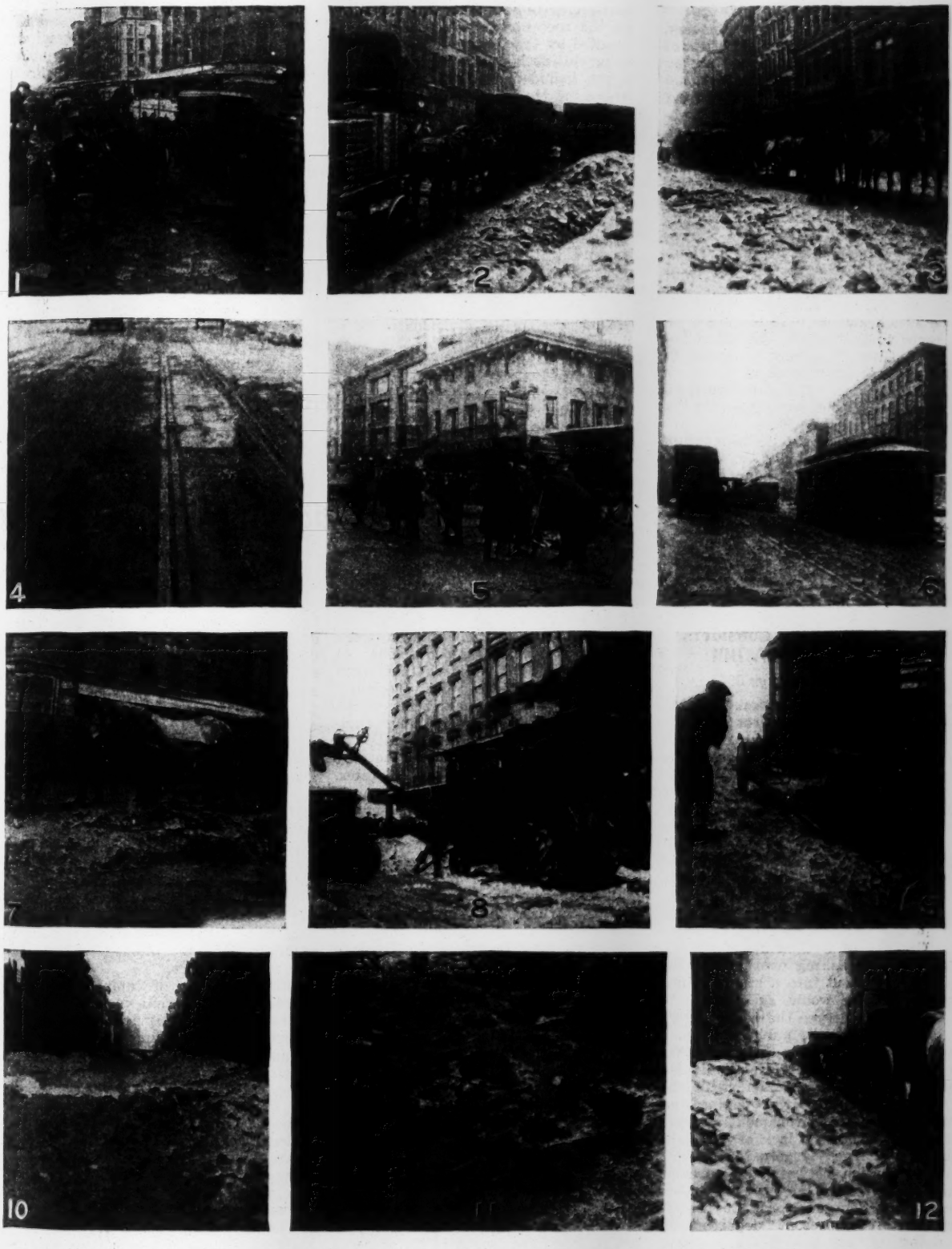
Constitution Is Drafted

Following a canvass of representative opinion which showed reserve officers and others who had been in the engineering service during the war to be strongly favorable to such an organization, the committee drafted a provisional constitution and created a temporary board of directors from its membership. This constitution is already being submitted for approval or comment to individuals who are known to be interested in the organization and eligible to membership; its more important features follow:

The annually elective officers are to be a president and first and second vice-presidents. The president is to be an officer of the Corps of Engineers on the active list. There is to be a secretary, an editor and a treasurer chosen by an executive committee, the first two from the Regular Army. A board

(*Concluded on page* 396)

The Aftermath of New York City's Big Snow Storm



1. Traffic Jam on West St., near Waterfront. 2 and 3. On Lower Broadway Four- and Six-Horse Teams were Needed to Move Trucks. 4, 5 and 6. Street Railway Slots, Choked with Ice, Had to Be Cleaned Before Abandoned Cars Could Be Operated. 7. Showing Thickness of Ice Layer. 8. Steam Shovel Loading Snow on Motor Truck on Broadway. 9. Truck Stalled by wheel in Crater. 10. Too Deep for Traffic. 11. The Reason Why Traffic Was Tied up. 12. Long Traffic Line Stalled in Lower Broadway.

Military Engineers' Society Is Being Organized

(*Concluded from page* 394)

of directors, to have eighteen members, is to be elected by the three divisions of active membership, as follows: six by the Regular army; six by the National Guard and reserve forces, and six from the membership, exclusive of the foregoing two groups. There is to be an executive committee consisting of the president, the two vice-presidents, and not to exceed three others, to be elected annually by the board of directors from its own members. Other standing committees are: Rules and Ethics; Auditing; Finance; Membership, Nominations and Necrology; Service Relations and Military Policies.

The annual meeting is to be held in Washington, and its date is fixed with reference to that of the American Society of Civil Engineers in order to make possible attendance of members at both meetings. The dues are fixed not to exceed $5 per year, those for the present year being $4.50.

The society is to publish bi-monthly a journal to be called *The Military Engineer*, which will supplant *Professional Memoirs*, heretofore published by the Corps of Engineers.

Further information regarding the society may be secured from Col. G. A. Youngberg, office Chief of Engineers, Washington, D. C.

Senate Committee Considers National D. P. W. Bill

(*Concluded from page* 394)

that the legislation being sought is in the interest of the public as a whole and that engineers, as such, will not be the chief beneficiaries. He made the point that, with the Government spending $788,000,000 on public works, such great activity along one line should be grouped under one head who, as the bill specifies, is to be a man of requisite training and experience. He stated that he is a great admirer of the Engineer Corps of the Army and in its own interest would like to see river and harbor work taken from it. Senator McNary of Oregon expressed the fear that the making over of the Interior Department into a strictly engineering activity would subordinate to an undesirable degree the department's administration of the public domain.

Mr. Cranford told the committee that the bill has practically the undivided support of all the contractors in the country. Much of the engineering work done by the Government at present, he said, shows a lack of foresight which he charged largely to the lack of co-ordination between the bureaus. This called forth an interjection on the part of Senator Norris to the effect that the present departmental grouping of bureaus seems to have been brought about by nature rather than by man. Mr. Cranford said that the head of the projected Public Works Department would have a bird's-eye view of all engineering plans and requirements and could conduct these important Governmental activities with the necessary vision. Arguments presented by Col. Gunby advocated the placing of such activities as are at present included in the Construction Division of the Army under the proposed new department.

Interests of Army Engineers

Mr. Blossom read into the record a portion of his final report to the War Department, in which he urged the Secretary of War to support the Public Works Department idea. During Mr. Blossom's testimony Senator Kendrick suggested that the legislation could be obtained so much easier if the Interior Department could be divided into two divisions, one of the divisions to be a public works division. To this suggestion Mr. Leighton replied that there would be so little left for the other division as to give no advantage in such a separation while it would interfere with the plan for straight-line control of the engineering bureaus by a man who thoroughly understands engineering.

Mr. Baker called attention to the fact that the bill enables officers of the Corps of Engineers to be detailed to service in any bureau of the Department of Public Works. They would thereby receive a varied experience which, he asserted, would fit them far better for military service in time of war than does their present work on river and harbor improvement. It was recalled by Mr. Baker that when the army engineers were originally placed in charge of navigation works they were practically the only engineers available, for West Point was then the principal and almost the only engineering school in the United States. He went on to show that at the present time, however, there is a multitude of engineering colleges which give a far better training in engineering than does West Point. The United States should have the ablest engineers from these schools for its public works, he maintained, and should so utilize its military engineers that they may become best fitted to render useful service in time of war

Train Wrecks St. Louis Viaduct

A pullman car in a train running at a speed of 25 mi. per hour toward the Union Station in St. Louis, Mo., at 2 p.m., Feb. 12, was derailed at a switch when about to pass under the 14th Street viaduct and knocked out a column of the structure. The viaduct, bearing a street car with several passengers, dropped 10 ft. to the roofs of the cars on the tracks below and rested there. The structure is nearly 300 ft. long; the length of the sag was 110 ft. Eight persons in the street car and one in the pullman were slightly injured.

Wood Preservers Adopt Fir Paving Block Specifications

More than 200 engineers, officials of railroads and companies interested in the preservation of wood by chemical treatment attended the 16th annual meeting of the American Wood Preservers Association Feb. 10, 11 and 12 in Chicago. The necessity of financing a campaign of education on approved methods of laying wood-block paving was one of the most important items in the address of the president, J. B. Card. Only Minneapolis and a few other cities had changed over to specifications adopted by the association last year which call for a pitch-paint coat on top of the concrete base instead of sand or dry mortar. Mr. Card's opinion was that a fund of at least $25,000 can be raised for such educational work. Details are in the hands of the executive committee.

It was established that wood-block pavement can be constructed between street car tracks although its reputation for good practice has suffered much from lack of information on the part of the builders as to the requirements of rigid foundation and of laying on a thin bituminous cushion. A specification embodying these principles was presented for information only by the committee on wood-block flooring and paving.

The specifications presented and adopted for the treatment of Douglas fir blocks brought out a discussion of the difficulties encountered in St. Louis last summer due to excessive contraction during an unusual period of hot and dry weather. Dr. Herman Von Schrenk stated that the details would soon appear in a paper by W. W. Horner in *Engineering News-Record*. E. M. Blake, who acted as sponsor for the specifications, stated that they were adopted by the best informed experts and users on the Pacific Coast and the moral support of the national organization was desired to insure their acceptance by municipalities. Pertinent clauses call for the treatment of either seasoned or green wood, according to climatic conditions, by the vacuum boiling method. Some objection was made that the Association already had a standard "boiling" method with which this might conflict.

Other features of interest to engineers in the program were: The records of long-time service of piles in a wharf in San Francisco Bay; the progress obtained by the use of perforating machines in making uniform the penetration of treatment on Douglas fir; a discussion of the relative value of various methods of tie separation; the detrimental effect of an unusually hot and wet season on the extraordinarily large cut of sap pine ties in the Southwest; and a tie renewal record of the D., L. & W. R.R.

The Forest Products Laboratory has built up a mass of service test records of ties and a catalog of these tests showing the kinds of wood, preservation and absorption has been printed

by the association. Details of any set of tests with results continually being brought down to date may be obtained from the laboratory.

Specifications adopted at annual meetings have always carried the proviso that the measure must go to letter-ballot for final official approval. By the constitution a two-thirds positive vote of the whole corporate membership is necessary. In consequence of this restriction no measure has yet been finally approved, although many have received much more than a majority. Amendments were adopted making final action contingent on a two-thirds affirmative vote of those voting.

The officers elected for the ensuing year are as follows: A. R. Joyce, president; C. M. Taylor and V. K. Hendricks, vice-presidents; F. J. Angier, Baltimore, secretary-treasurer. The 1921 meeting will be held in San Francisco.

Bills to Aid Assistant Engineers on River, Harbor Work

Two bills relating to the United States Assistant Engineers engaged on river and harbor work have been introduced in the House of Representatives. One provides for making these civilian assistants commissioned officers of the army; the other bill continues their civilian status but provides an increase in salaries and provision for retirement. There seems little prospect that either of these bills will be pressed for passage. There is no doubt whatever that the United States Assistant Engineers have for many years been paid wholly inadequate salaries and have held no standing proportionate to their responsibility. There is hope now of remedying this long standing evil, through the passage of the pending Jones-Reavis bill establishing a Department of Public Works, which would take over the work on rivers and harbors now under direction of the Corps of Engineers. These civilian assistants would doubtless be transferred to the new department. Their long experience would be utilized, and there is every reason to believe would be recognized by adequate compensation.

Illinois Drainage Conference

The third annual conference on land drainage, organized by the University of Illinois, will be held at the university on March 16-18, and is intended to bring together engineers, attorneys, contractors, landowners and others interested. It is planned to have specific sections of the State of Illinois dealt with at certain sessions in order to provide for the presentation of local problems. Among the general subjects to be considered are the straightening of river channels, the organization of drainage districts and the protection of bottom lands by levees. G. W. Pickels, Urbana, Ill., is chairman of the conference.

Resolution Against Architect as Bridge Designer

Additional engineering opinion concerning the Pennsylvania Art Commission's claim that an architect rather than an engineer should design the proposed Delaware River bridge at Philadelphia was expressed in a recent resolution of denial by the Philadelphia Association of Members of the American Society of Civil Engineers. It was further voted at the meeting to take up with the Engineers' Club of Philadelphia, and other engineering societies, the appointment of a committee to place before the proper authorities the desirability of appointing a competent civil engineer to design and build the bridge.

Without the preamble the association's resolution is quoted:

1. This association reiterates its judgment as expressed in a resolution adopted Nov. 24, 1919, that "safety to human life and the proper expenditure of public funds require that the design and erection of such structures be under the responsible charge of competent and experienced civil engineers, especially skilled and trained for that class of work."

2. This association desires to see full consideration given to the proper placing and the aesthetic treatment of the Delaware River bridge by a qualified architectural consultant, or consultants, preferably chosen by, but certainly responsible to the Chief Engineer, who alone can finally harmonize the claims of beauty and art with the primary necessities of structural safety and reasonable cost.

Denver Commerce Body To Study Water-Meter Proposal

A committee has been appointed by the Denver Civic and Commercial Association to investigate the merits of a proposal that water meters be installed by the Municipal Water Commission. So long as the water system was in private ownership the question was never brought up, although the company officials had exhaustive studies made of the effect which a restricted use of sprinkling would have on lawns. During the summer of 1919 Boy Scouts were employed to patrol certain sections and report consumers sprinkling outside of the restricted hours.

Believed Beach Will Support Big River, Harbor Appropriation

(*Washington Correspondence*)

General Lansing H. Beach, recently confirmed as Chief of Engineers, has arrived in Washington and has taken up the active discharge of his new duties. It is believed that General Beach will stand strongly behind Colonel Harry Taylor in insisting that $19,000,000 for improvements and $5,000,000 for maintenance constitute an irreducible minimum for river and harbor appropriations.

Road Builders Discuss Only Highway Fundamentals

Small Attendance at Annual Convention Most Concerned With Elementary Factors of Construction

Emphasis of the fundamentals of highway design and construction was the outstanding feature of the annual convention at Louisville, Ky., Feb. 9-13, of the American Road Builders' Association. In many of the papers presented, but more especially in the discussions from the floor, the elementary factors of alignment, width, gradient and permanent foundation construction with thorough drainage as the vital requirement, were given prominence. This lifting of essentials of good highway engineering into clearer view, above the fog of discussion about road surfaces, did much toward justifying a meeting which, in many respects, was a failure.

There was a small and unrepresentative attendance of highway engineers and contractors. Scarcely a hundred of both were present and from whole sections of the country there had not come a single highway official of first importance. Attendance at the sessions was small. Sometimes there were a hundred members and visitors in the convention hall, but more often only half of that number were present. A considerable percentage of the papers listed were not read, as their authors were not present. Many others were presented in incomplete form. Some had not been written and oral summaries were substituted by the authors. The equipment exhibition was representative, was fairly extensive, was attractively arranged and was displayed by skilled demonstrators. It had very few visitors.

Highway Fundamentals

Prompted by papers by H. G. Shirley and W. G. Thompson on the subject of fundamentals in modern highway construction there was an active discussion of line, width, grade, and foundation construction which led to the following conclusions: (1) Direct alignment and elimination of curves to the utmost extent consistent with sound engineering economics is an essential in heavy traffic road construction; (2) for main traffic roads pavement widths of 20 ft. and grade widths of 30 ft. are not too great to provide properly for future traffic developments; (3) foundation design must be based, not on state standards, but upon the soil and drainage conditions found to exist where the road is being built, and the thickness and the character of the foundation should differ as frequently as the influencing conditions of soil and drainage differ; (4) the design of foundations requires extension of the available knowledge concerning the moisture content of soils, the effectiveness of different methods of drainage, and the intensity and nature of the stress which modern motor-vehicle traffic brings upon the subgrade.

Premised upon these conclusions the speakers generally commended the work of the Bureau of Public Roads in testing road slabs for impact, for resistance to abrasion and for action under different conditions of saturation of the sub-base. The attitude of the Bureau in contending that the allotment of Federal-aid funds to permanent work in building up roadbed by improving alignment and grades, by widening and building up roadbed and by deepening and draining foundations, was commended for its influence in emphasizing highway fundamentals.

CONSTRUCTION PROBLEMS

Alterations in practice to make highway contracting more attractive to large construction organizations were summarized by R. G. Collins, Jr., of the Associated General Contractors of America, on about the lines of his article in *Engineering News-Record* Jan. 15, 1920, p. 122. Replying on behalf of highway engineers C. M. Upham summarized the six essentials to satisfactory co-operation as follows, presuming an honest contractor on one hand and an honest engineer on the other: (1) Substantial highway department administration and competent commonsense engineering; (2) reasonable constructive requirements definitely stated; (3) absolutely competent inspection; (4) adequate equipment to conduct construction; (5) sufficient funds to finance construction without delays; (6) skilled and competent construction management.

Sand and Gravel Producers Meet

Co-operation of industrial and technical associations as an effective means for promoting the interests of an industry was brought out in a report presented at the annual meeting of the National Association of Sand and Gravel Producers, held in Chicago on Feb. 11 to 13. One of the lines of its activity has been in securing the help and co-operation of several such associations as the American Society for Testing Materials, the American Concrete Institute, the Bureau of Standards, the U. S. Geological Survey, and the Portland Cement Association. Gravel concrete for roads and other purposes was one of the leading subjects of discussion in the meeting. A paper on "Tests of Sand and Gravel Concrete" was presented by Prof. W. K. Hatt of Purdue University, president of the American Concrete Institute. He dealt particularly with the relative wear of concrete of various mixes and aggregate sizes. Another paper was on standard sizing for sand and gravel by Prof. T. R. Agg, Iowa State College.

Cornell President Resigns

The announcement was made Feb. 14 of the resignation of Dr. Jacob Gould Schurman as president of Cornell University. His successor has not yet been chosen.

R. A. Ross, President of Engineering Institute of Canada

Supplementing the announcement, last week, of the election of R. A. Ross as president of the Engineering Institute of Canada, additional biographical data, received too late for the issue of Feb. 12, is now presented.

Born of Scotch ancestry in 1865, Robert Alexander Ross, after graduation from the public and high schools of his birthplace, Woodstock, Ont., was apprenticed to Robert Whitelaw, an engine builder of that place. Upon completion of his full time as apprentice machinist, he entered the School of Practical Science, University of Toronto, whence he graduated in 1890. During the three years subsequent to his graduation he was in charge of the engineering department of the Canadian General Electric Co. at Sherbrooke. In 1893 he was appointed chief electrical and mechanical engineer of the Royal Electric Co. of Montreal, having charge of all engineering work in station and shops.

Since 1896 Mr. Ross has been engaged in consulting practice and has been responsible for the designs of many important electrical and power installations including: The West Kootenay Power and Light plant at Bonnington Falls, B. C.; the Huronian Co.'s plant and that of the Canadian Copper Co. at Copper Cliff, Ont.; the Canadian Pacific Railway shops at Angus; the Westmount Electric plant; the West India Electric Co. plant in Jamaica; the Farnham power plant at Farnham, Que.; Convocation Hall, University of Toronto; and the Central Heat, Light and Power Co. plant at Montreal.

At various times Mr. Ross has acted as consultant to the Hydro-Electric Power Commission of Ontario, the Canadian Pacific Railway, and the great majority of the larger cities throughout the Dominion. In addition to his work in Canada, he has carried on engineering operations in China, India, Straits Settlements, Russia, Finland, Scotland, Australia, Jamaica and the United States. A few years ago when the City of Montreal became involved in what is known as the "aqueduct muddle" Mr. Ross took a leading part in organizing the rate-paying engineers of the city and directing their efforts in an educational campaign on the water-supply situation, which resulted in a saving of several million dollars to the city.

When the Honorary Advisory Council for Scientific and Industrial Research was established four years ago by the Dominion Government to promote and encourage research in connection with the development of the natural resources of Canada and to assist manufacturers with their problems, Mr. Ross was made a member of that body. He was chairman of the Lignite Utilization Board of the Council, and as such has carried on investigations which have arrived at a point where commercial lignite plants will be established in Western Canada very soon. Two years ago at the earnest solicitation of his friends Mr. Ross with an exceptional spirit of public service gave up his active engineering practice to become a member of the Administrative Commission of Montreal created by the Provincial Government to straighten out a chaotic condition said to have existed at that time in the city's affairs. In that capacity he served with distinction.

Track and Shop Workers' Strike Order Suspended

The order for a country-wide strike of railroad maintenance-of-way and shop employees, which was to have become effective Feb. 17, was suspended on the day following the conference between the unions' officials and President Wilson, Feb. 13.

The demands of the unions, together with the trainmen, had been refused by Director General of Railroads Walker D. Hines, and the labor leaders had rejected his counter proposals. Complete details of the negotiations were not made public. President Wilson's proposals include a plan for settling present differences in accord with the provisions of pending legislation and an alternative plan providing a commission or board to be appointed by the President. Officials of the unions appear to lean toward the latter plan.

Conferees Reach Final Agreement on Railroad Bill

Final agreement on a report to Congress of a new railroad law was reached by the House and Senate conferees Feb. 16. Aside from changes in text, the general features of the compromise bill follow the principles of the tentative agreement reported in *Engineering News-Record* last week, with the exception of the labor provision, which was modified so as to provide for a Federal appeal board appointed by the President and consisting of nine members equally divided between the employees, employers and the public. As previously agreed upon this board was to have been composed of five members.

The new labor provision results directly, according to Senator Cummins, chairman of the Senate conferees, from the threatened strike of maintenance-of-way employees.

W. S. E. Co-operates With Commerce Bodies on Water-Works

Immediate needs and future plans for the extension of the water system of Chicago are being considered by committees appointed at the invitation of the city engineer, P. S. Combs, from the membership of the Western Society of Engineers, the Chicago Association of Commerce, the Cook County and Chicago Real Estate Board and the Illinois Manufacturers' Association. Mr. Combs' idea is to bring the existing condition of the system, which he

states is critical, to the attention of technical organizations as well as the business interests. A scheme has been laid out involving an immediate rehabilitation outlay of $2,500,000 and an ultimate expenditure of $61,000,000 by 1950. Detailed plans with financial statements for submission to a small working sub-committee of the above organizations are nearly completed by the city engineer's office.

For the Western Society of Engineers the committee is Charles B. Burdick, Dabney H. Maury, William Artingstall and W. W. DeBerard. John W. Alvord, chairman of the engineers' sub-division of the Chicago Association of Engineers, is the engineer representative of that body.

High Prices Postpone Water-Works Construction

Owing to the heavy increase in the prices of cast-iron pipe and fittings the city officials of Youngstown, Ohio, have temporarily abandoned the construction of a belt water main around the city. Bids for 5,800 tons of pipe received early in February were at the rate of $71.80 a ton, or $20 in excess of the prices paid a year ago. The City Council had authorized a bond issue of $600,000 for the first section of the belt line, the entire length of which was estimated to cost $1,500,000. Bids for this first section were $150,000 in excess of the estimate.

Texas Water-Works Association Organizes

Permanent organization of the Texas Water-Works Association was effected at a recent meeting of superintendents of water plants of Texas in Austin. E. L. Fulkerson, superintendent of the Waco plant and secretary of the Southwestern Water-Works Association, was elected president. V. M. Ehlers, sanitary engineer of the State Health Department, was selected as secretary, and R. G. Tyler of the University of Texas is the first vice-president.

Annual Meeting Material Handling Machine Makers

At the annual meeting of the Material Handling Machinery Manufacturers' Association in New York City Feb. 26 and 27, will be presented several addresses and papers on mechanical moving of materials.

The first morning session, on the 26th, will be devoted to the annual committee reports and the election of new members to the board of governors. The other sessions will be devoted to the papers scheduled for reading and discussion. Figures resulting from a survey made by the association will be presented to show that a greater use of handling machinery by the railroads would save them from $35,000,000 to $40,000,000 per year, while shipping terminals could save $10,000,000 to $20,000,000 annually.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN RAILWAY ENGINEERING ASSOCIATION; 1426 Manhattan Bldg., Chicago; March 16-18, Chicago.

AMERICAN ASSOCIATION OF ENGINEERS; 29 S. La Salle St., Chicago; May 10, 11, St. Louis, Mo.

The Colorado Association of Members of the American Society of Civil Engineers held its 109th regular meeting in Denver, Colo., Feb. 14. A report of a committee to secure data in connection with the proposed Continental Divide tunnels was made.

The Louisiana Engineering Society heard a paper on "Fabricated Steel Ship Construction as Developed by the Doullut & Williams Shipbuilding Co., Inc.," written and delivered by James P. Ewin, at its regular meeting in New Orleans, Feb. 9.

The Montreal Branch of The Engineering Institute of Canada at its regular weekly meeting of Feb. 12 was given an illustrated lecture on "Ice Formation" by John Murphy. The subject for the meeting of Feb. 19 is "Aerial Photography in War," to be covered by Lieut. C. C. Brooks, M. C.

The Brooklyn Engineers' Club heard a paper on the "Pressure and Resistance of Soils" by James C. Meem at the regular weekly meeting in Brooklyn, N. Y., Feb. 12. At the meeting of Feb. 19 John R. Rogers will deliver a paper on "History of the Linotype."

The Kansas Engineering Society in annual meeting Jan. 20 and 21 installed the following officers for the ensuing year: H. A. Rowland, president; Dean P. F. Walker of the College of Engineering, Kansas University, vice-president, and Lloyd B. Smith, secretary-treasurer.

The Engineering Society of Buffalo held a general meeting in Buffalo, N. Y., Feb. 10. The speaker was Dr. W. D. Bancroft, chairman of the Division of Chemistry and Chemical Technology, National Research Council. His subject was "The Chemical Work of the National Research Council."

The Milwaukee Chapter, A. A. E., has elected the following officers for 1920: A. E. Holcomb, president; N. Prakken, vice-president; C. S. Gruetzmacher, secretary, and Wm. Tubesing, treasurer.

The Duluth Engineers' Club held its regular monthly meeting for February on the 16th. Two addresses were made on chemical subjects.

The Engineers' Club of the Youngstown (Ohio) District, through its executive board, on Feb. 3 appointed the following committee chairmen for the year 1920: Fred Hubbard, public relations; F. C. Jenneaut, finance; L. H. Underwood, program and entertainment; S. G. Hobert, library; E. J. Kauffman, membership; H. D. Chase, house; A. E. Lasher, publicity and publication. The new chairmen have pledged themselves to make their club the headquarters for engineering activity in connection with all civic improvements and municipal welfare throughout the district.

The Albany Society of Civil Engineers now has 142 members. Its officers recently elected are: Frank H. Macy, president; Emory E. Brandow, first vice-president; Germain P. Graham, second vice-president; Thomas L. Watkins, third vice-president; John W. Carpenter, librarian; John W. Henry, secretary-treasurer.

The Indiana Sanitary and Water Supply Association will hold its next annual meeting at French Lick, Ind., March 8 and 9.

The Santa Fe Coast Lines Railroad Section of the A. A. E. held its first annual convention in Los Angeles on Jan. 10. Constitution and by-laws were ratified and committees appointed. Divisional representatives were also appointed and a banquet and dance was held in the evening. C. R. West is president and L. E. Smith is secretary.

The Portland (Ore.) Association of Members of the American Society of Civil Engineers at a dinner in Portland, Ore., Jan. 9, elected the following officers to serve during 1920: J. C. Stevens, president; M. E. Reed, first vice-president; F. M. Randlett, second vice-president; C. P. Keyser, secretary, and Chas. J. McGonigle, treasurer.

The Detroit Engineering Society and the Ann Arbor Section of the American Institute of Electrical Engineers in joint meeting at Detroit will be addressed by W. D'A. Ryan on the subject of general illumination. Mr. Ryan is director of the illumination engineering laboratory of the General Electric Co. He designed the illumination for the Panama-Pacific Exposition.

The Engineers' Club of Trenton met in Trenton, N. J., Feb. 12 to hear Charles Ferguson deliver an address on "The Relation of Financial Credit to the Labor Problem."

The Washington Irrigation Institute, at its annual meeting in Spokane, Wash., Jan. 8-9, 1920, elected the following officers for the ensuing year: E. F. Blaine, president; E. F. Banker, first vice-president; N. W. Moulton, second vice-president, and N. W. Durham and Ralph B. Williamson, directors.

The Minnesota Surveyors and Engineers' Society will hold its 25th annual meeting in Minneapolis, Minn., Feb. 19, 20 and 21, and the Minnesota Joint Engineering Board will give its annual banquet the evening of the 20th.

PERSONAL NOTES

THOMAS H. MACAULEY, who has been manager of the Municipal Railway of Calgary, Alberta, since 1909, has recently become general manager of the New Brunswick Power Co. at St. Johns, N. B.

PROF. O. W. SJOGREN, instructor in agricultural engineering in the University of Nebraska since 1909, has been appointed chairman of the University's Department of Agricultural Engineering. He succeeds Prof. L. W. Chase who has resigned to enter the manufacturing field.

EARL W. SAYLES, appointed city engineer of Watertown, N. Y., 11 years ago, has tendered his resignation to be effective April 1, 1920. It is reported that Mr. Sayles' present intention is to engage in private practice in the West.

NEWTON A. K. BUGBEE, president of the N. A. K. Bugbee Co., engineers, Trenton, N. J., has been reelected State Comptroller by the New Jersey legislature.

MICHAEL M. BURRIS has resigned as city forester of Trenton, N. J., to devote his entire time to the business of Black, Burris & Fiske, Inc., recently organized in Trenton to carry on a landscape service.

GEORGE E. TAYLOR has resigned as chief engineer of the West Virginia Public Service Commission and entered a consulting engineering partnership with J. K. Anderson whom he had succeeded in that office following the latter's resignation last summer. The new partnership will specialize in public utility valuations and rate cases.

COL. GABRIEL R. SOLOMON, recently with the Engineering Branch, Construction Division of the Army, has been discharged from the service and has resumed his engineering practice as vice-president of the Fuller Industrial Engineering Corp., New York City. Before entering the military service Colonel Solomon was a member of the Solomon-Norcross Co., consulting engineers of Atlanta, Ga.

JOHN N. CARLISLE, former New York State public service commissioner and commissioner of highways, has been appointed chairman of an Albany, N. Y., Chamber of Commerce committee to promote the industrial improvement of Albany's South End.

CHARLES BROSSMAN, consulting engineer of Indianapolis, Ind., has been retained by the Anderson, Ind., board of public works to make a survey and report recommending extensive improvements to the city's lighting plant.

PROF. T. P. BRANCH, dean of the department of civil engineering of Georgia School of Technology, has been elected president of the Affiliated Technical Societies of Atlanta, Ga.

M. O. BELLINGRODT, recently assistant engineer of the Georgia & Florida Ry., has been appointed bridge engineer in the Georgia State Highway Department.

E. D. MURPHEY, chief engineer of the Arkansas Actuarial Bureau, was recently appointed assistant manager of the bureau as well.

W. A. WINBURN has been elected president of both the Central of Georgia R.R. Co. and the Ocean Steamship Co.

GEORGE T. AUSTIN has been retained as city engineer of Effingham, Ill.

LEROY F. CLARK has tendered his resignation as city engineer of Batavia, N. Y., to take effect March 1. It is reported he will enter a partnership with Frank H. Homelius, architect of Batavia.

FRANK R. SHAW has filed his resignation as city sanitarian of Dallas, Tex., effective March 1. Mr. Shaw is leaving that city's service to engage in practice as consulting engineer.

C. R. STANHOPE has been appointed city engineer of Ashtabula, O., to succeed L. A. Amsden, who resigned after 21 years in that office. Mr. Stanhope had been the assistant city engineer for the past four years

GEORGE W. JACKSON, contractor and builder of many water tunnels in Chicago, and those of the Illinois Tunnel Co., has been employed by the latest Chicago traction commission to prepare estimates of cost of building subways in practically every street in the loop district.

W. A. SANDERS and F. R. SWEENY have announced their formation of the firm of Sanders & Sweeny to engage in consulting and constructing engineering with headquarters in Anderson, S. C.

New Industrial Truck Moves and Elevates Material

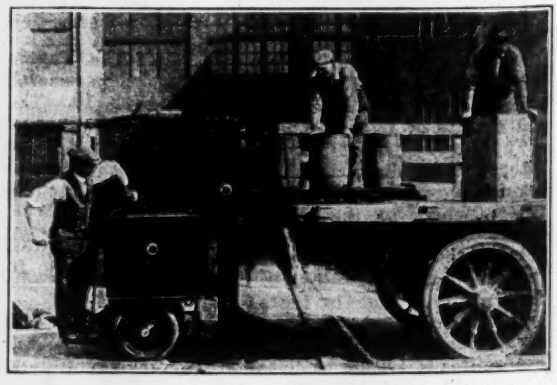
A new industrial truck has been developed which with its own power elevates its load to sufficient heights to put material in box cars, stock rooms or trucks without rehandling, and which performs all the functions of a tiering machine as well as those of a load-carrying, storage-battery truck.

The truck, a product of the Lakewood Engineering Co., and called the Tier-lift, is said to serve practically every purpose of a load-carrying industrial truck, and in its high-lift feature to more than double the field of usefulness of the ordinary load carrier. The Tier-lift will with its own power elevate a two-ton load to a maximum height of 76 in. or to any intermediate height.

Material heretofore moved by hand trucks or power-driven trucks which acted as carriers only, and elevated to piles, freight cars or trucks by manlift or by separate equipment can now be moved and lifted to place by a single power unit. The economical height to which material can be piled is greatly increased and the storage capacity of a given floor space doubled or tripled by the high-lift feature. Storing material on skids so that re-handling of material in storeroom is entirely eliminated is made practical and when the material is such that it can bear the weight of loads above, loaded platforms can be piled on top of each other. Labor cost is thus reduced to a minimum, material can be handled more quickly and storage of the floor space is increased 200 per cent or more, it is claimed. The Tier-lift makes possible also a new method of storing which permits the selection of loads from specially designed racks. By the arrangement devised, any loaded platform in the racks may be removed without disturbing the other loads, thus giving greater flexibility to a storeroom.

The work drive is the same as that used in the Lakewood tractors and trucks. The 4-wheel steer permits turning in a circle of 92 in. radius. This allows easy turning in narrow aisles or congested parts of the plant, and gives easy entrance into box cars.

There are three speeds forward and three speeds reverse. The controller handle is conveniently located for operation for travel in either direction. The lifting mechanism is operated by means of a specially designed controller with one speed in either direction. The lifting is done by means of worm screws. A separate motor is used to raise the load. The load platform is carried by a cantilever type support and the load is balanced over the load carrying wheels. Ball bearings are used throughout and by a special design the friction losses in elevating and lowering the load platform are said to be practically eliminated.



MATERIAL MOVER ALSO ELEVATES TO HEIGHT OF RECEIVING PLATFORM